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Ministry of Defence

Preface

# The Nassau Connection

## The Organisation and Management of the British POLARIS Project

Peter Nailor

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First published 1988

ISBN 0 11 772526 9

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# Preface

This work was undertaken at the invitation of the Ministry of Defence. Many people in the Ministry of Defence, the former Ministry of Aviation and in the United States Department of the Navy gave most generously of their time, as did representatives of major contractors, notably the Vickers Shipbuilding Group and the British Aircraft Corporation, and a number of participants in the joint United States-United Kingdom POLARIS programme who have now retired from the public service and from the industry. Material derived from these interviews has formed an important part of the material, and has been noted in the text, but without attribution to individuals. My thanks are particularly due to Rear Admiral C. W. H. Shepherd, from whom the invitation, and the opportunity to undertake the book, directly arose and to Vice Admiral Sir Hugh Mackenzie, who has given support and encouragement at every stage.

My former colleague, Michael Dillon, has been a substantial contributor to what follows, especially in regard to the material relating to Shipyard Progress and to the interview programme which I have described: but, of course, the responsibility for any errors that may have slipped through remains mine. The bibliography has been amended to reflect additional material that has been published since the monograph was first prepared.

P.N.

Preface

For Rufus Mackenzie, and his colleagues on both sides of the Atlantic, who showed that what ought to work in theory can work in practice.

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# Glossary of Abbreviations

ACO	The Admiralty Compass Observatory, Slough
AEA	The United Kingdom Atomic Energy Authority
AEC	The United States Atomic Energy Commission
BNBMS	The British Naval Ballistic Missile System (the formal name of the programme commonly called the UK POLARIS Programme)
BUShips	The Bureau of Ships in the US Navy Department
CPE	Chief Polaris Executive (either the Chief Executive himself or his organisation)
DGD and M	The Director General, Dockyards and Maintenance
DGS or DG Ships	The Director General, Ships
DGW	The Director General, Weapons
DOPC	The Defence and Overseas Policy Committee (of the Cabinet)
DPT	DREADNOUGHT Project Team: also Technical Director, Polaris Executive
EB	Electric Boat Company
FBM(S)	The United States Fleet Ballistic Missile (System)
FOSM	The Flag Officer, Submarines
ICBM	Inter-Continental Ballistic Missile
IRBM	Intermediate Range Ballistic Missile
JSTG	Joint Steering Task Group
MLF	Multi-lateral Nuclear Force
MOA	Ministry of Aviation
MPBW	Ministry of Public Building and Works
MRBM	Medium Range Ballistic Missile
OSD	Office of the Secretary of Defence
PLO	Polaris Logistics Officer
R and D	Research and Development
SP	Special Projects Office (in the US Navy Department)
SSHA	Scottish Special Housing Association
STG	Steering Task Group

# Introduction

## Background

The POLARIS programme was, by any standard of comparison, a significant undertaking. It was urgent, it was costly; it represented, for British security interests as a whole as well as to the Royal Navy, a major challenge to their ingenuity and skill. And it was completed within the required timescale and within the forecast budget. In these regards at least, it has a singularity that calls for some explanation, which is why this book has been written.

It is an account, therefore, of the management organisation and effort that was applied to the programme that was foreshadowed by the agreements reached at the Nassau Conference in December 1962, and reached the first stage of its accomplishment when the Royal Navy assumed the responsibility of deploying the main strategic deterrent force from the Royal Air Force in July 1969. It is incomplete, in the sense that it does not carry the story forward to the equally taxing task of maintaining and servicing the deployed force, nor does it do more than touch on aspects of the operational problems that a submarine-based force has to deal with. The prime concern is to describe and explain how the POLARIS force and its supporting activities were created and set to work.

# *The Historical Background*

Although the first British atomic device was tested in October 1952, the British strategic nuclear deterrent effectively came into being in the period between 1956 and 1960, when the first generation of V-bombers passed into operational service and, progressively, became equipped with nuclear and thermo-nuclear weapons in the megaton range. In the same period plans were laid for a successor system to replace the V-bombers as the main delivery system.

It was a time of technological change so rapid and so extensive as to be bewildering, when efforts made at the political and military levels to place this awesome new range of force into some sort of coherent relationship with national and alliance interests led, in the West, to confusion and dissension and, in the East, to studied reticence at the military level and occasional bombast at the political level. In the United Kingdom, the initial production programmes, of weapons and of delivery vehicles, were a national and independent activity, but after 1954, and especially after 1957, British success in manufacturing their own weapons opened the way to a resurgence of co-operation and information exchanges with the United States. In the same period, the rapid development of Soviet nuclear capabilities led the United States and the United Kingdom (and then subsequently France) to plan delivery systems which not only utilised the fast developing technologies that reduced the bulk of the nuclear weapons themselves but would look beyond the capabilities of manned flight, on which all the first generation deterrent forces were based. The advent of "hydrogen bombs" changed both the destructive power of a nuclear arsenal and the scale on which such power could be provided: the era of "atomic paucity" which had been based upon the early difficulties experienced in processing enriched uranium was very short-lived, and its passing shifted the crucial cost of a nuclear capability from the weapon itself to the delivery system, which would have both to penetrate defences and be sufficiently responsive to avoid, or survive, a pre-emptive attack.

The first choice for a successor to the V-bombers which the United Kingdom government made, in 1956-7, was BLUE STREAK, a liquid-fuelled missile with a range of about 2,000 statute miles, the design for which was based in part upon the United States ATLAS system. It was

first designed to be launched from pads but later from under-ground siloes and would take a minimum of ten to fifteen minutes to prepare for launch. BLUE STREAK was preferred to a supersonic bomber design (the Avro 530) which had been expected to take between ten and twelve years before it could be in squadron service. BLUE STREAK was cancelled in 1960 as a military project. Cost was not the only reason for cancellation; part of the increase in cost was attributable to pioneering research into the problem of "hardening" the siloes and could have been represented as a necessary improvement. BLUE STREAK was overtaken by technology, especially by the development of reliable solid-fuel rocket motors that enabled a much higher and more flexible state of readiness to be maintained, and were already under development by the United States and the Soviet Union. The unexpectedly fast development of reliable inertial guidance equipment was also of significance, not least because it enabled much greater accuracy to be achieved over very long distances.

Before BLUE STREAK was cancelled, however, the United Kingdom government undertook a general review of its policy which, while it naturally concentrated upon hardware options, also sought to establish strategic aims and parameters. The consequences went beyond nuclear weapon systems, to include new arrangements for planning and controlling all research and development programmes, and also extended to an agreement to provide facilities in Holy Loch for United States naval forces and a decision to buy SKYBOLT air-to-surface missiles.<sup>(1)</sup> If SKYBOLT could be successfully developed and be mated to the V-bombers, it would prolong their active service life; but even though the deal was attractive on these grounds, as well as for its relatively cheap purchase price free of research and development costs, it still represented only a short-to-medium term solution. The general development of new air defence systems was seen as putting a finite limit to the credibility of bombers as nuclear delivery systems. For this reason, the review (and the public debate which accompanied it) also considered the possibility of purchasing the United States Navy POLARIS system. This was to be a solid-fuelled IRBM, launched underwater from nuclear-propelled submarines and was the naval analogue of the land-based MINUTEMAN system; they had both grown out of the review of future weapons policy undertaken by the Killian Committee in 1955 for the US Department of

(1) Strictly speaking, this was not a "package deal" in the sense that the SKYBOLT deal depended upon the Holy Loch agreement. The latter was in line with earlier agreements to allow the forward deployment of US deterrent forces, and the former represented a new level of co-operation in nuclear systems between the US and UK governments. But, from the British point of view at least, the two agreements moved consistently towards the dual aim of strengthening Anglo-American ties and of improving British capabilities.

Defense and were both at the stage of advanced development trials.<sup>(2)</sup>

The attraction of the POLARIS system for the United Kingdom was that it would enable the nuclear force to be moved out to sea, away from the highly vulnerable homeland, and would provide a more credible second-strike deterrent. These particular advantages of the system for the United Kingdom were noted as early as May 1957 by Senator Henry Jackson (Dem.: Washington), in a speech to the United States Senate.<sup>(3)</sup> His remarks provided ammunition for Mr. Patrick Wall in a debate on the Navy Estimates in the House of Commons in March of the following year.<sup>(4)</sup> But the purchase, or the construction, of an adequate POLARIS force looked as if it would cost considerably more than it was expected that SKYBOLT would cost; and it would involve the shift of responsibility for deploying the deterrent from the RAF to the Royal Navy. The RAF was unwilling to envisage this possibility, and the Navy was unenthusiastic.

A. J. Pierre says of this situation:

"In retrospect the failure of the Royal Navy to make a strong case to the Cabinet for acquiring POLARIS rather than SKYBOLT before, and at the time of, the BLUE STREAK cancellation, was an irresponsible mistake. The Admiralty had been watching the development of POLARIS closely since 1956 and recognized that it was an ideal strategic system for Britain because it was not subject to surprise attack (as was any weapon located on British soil), because it permitted a delay in retaliatory action (and, therefore, gave time for verification of the source of an enemy attack and consultation with the United States), and because it moved the nuclear force away from the homeland. But the Navy chiefs were not enthusiastic about POLARIS, being worried about its costs and the accompanying drainage of skilled technicians. The 'senior service' was more interested in maintaining the 'traditional' navy of surface ships which controlled the seas and was fighting for a new generation of aircraft carriers. It was unwilling to sacrifice a 'balanced' fleet on the altar of a seaborne nuclear force. The Board of Admiralty, therefore, put forth strong reservations to the entire 'independent deterrent' concept, rather than advising the Cabinet that if it was the Government's political policy to maintain the nuclear force, POLARIS was

(2) For a general account of the US POLARIS system and the organisation which developed it, the Special Projects Office, see H. M. Sapolsky, *The Polaris System Development*, (Cambridge, Mass. M.I.T. Press, 1972). Chapter 2 deals with the early period of development following the Killian Committee report. Early in 1954 there had been a technical breakthrough in the miniaturisation of warhead components and in February 1955 the Killian Committee strongly recommended the development of an IRBM of some 1500 n.m. in range as well as an ICBM. The general political environment is described in President Eisenhower's memoirs, *Waging the Peace* (New York, Doubleday, 1965), pp. 206 et seq.

(3) The text of Senator Jackson's speech, delivered on 27 May 1957, is reprinted in his book *Fact, Fiction and National Security* (New York, Macfadden-Barkell, 1964) pp. 59-66.

(4) *House of Commons Debates*, Vol. 583, cols. 1056-1057 (4 March 1958). See also *Stability and Survival* (London: Bow Group, February 1961) and *The Sunday Times*, 9 February 1958.



the most suitable weapon system for it. If the cost of the POLARIS submarines were to be separated, so that either they were not part of the regular Navy budget or the budget was proportionately increased, there would have been less opposition to the Navy's taking over the deterrent mission. But given the past rigid pattern of defence allocations this was not considered likely to occur. Nevertheless, some senior Navy officers acknowledged that the choice of SKYBOLT in 1960 was perhaps only a 'postponement' of POLARIS, and that the undersea missile might become the successor to SKYBOLT in the 1970's."(5)

The period between 1957–1961 was dominated by an extensive, and at times bitter, debate about nuclear weapons and their place in the wide range of British defence policy problems. The arguments ranged from a high ethical level, relating to disarmament, or at least arms control, through the field of international politics and the impossibility of full dependence upon American undertakings and nuclear guarantees, to a complex domestic political *mêlée* in which the separate Services were embroiled with the Minister of Defence of the day, and the two major parties conducted their own campaigns, between and among themselves and with the aid of the Campaign for Nuclear Disarmament. The RAF in 1960, saw SKYBOLT as crucial to the maintenance of its principal role, and the Royal Navy was preoccupied with defending itself against a challenge to its importance and utility that was novel and disturbing.(6)

However, they did take stock of what the implications of POLARIS might be. Successive holders of the post of Flag Officer Submarines (FOSM), who were the Board of Admiralty's principal advisers on submarine matters, had good professional relationships with their United States opposite numbers, and were able to report the general state of professional opinion on the implications for undersea warfare of the United States developments, in POLARIS as well as in more general submarine technology; and since October 1958 a staff officer had been added to the British Navy Staff delegation in Washington to liaise with the Special Projects Office. This appointment resulted from a personal approach from the First Sea Lord, Admiral of the Fleet Lord Mountbatten, to the Chief of Naval Operations, Admiral Arleigh Burke. More directly, and as a consequence of the policy review which led to the decision to purchase SKYBOLT, the Board of Admiralty commissioned an investigation which was to identify what the Admiralty would have to do if the United Kingdom decided to procure POLARIS. This investigation was undertaken by Rear Admiral M. Le Fanu, who had recently been the Director-General, Weapons; it was taken formally by the Board in July 1960, and became, in essence, a blueprint on which future action could be

(5) A. J. Pierre, *Nuclear Politics* (Oxford: Oxford University Press, 1972), pp. 220–201.

(6) The definitive account of the Whitehall in-fighting at this period is given in L. W. Martin's article "The Market for Strategic Ideas in Britain", *American Political Science Review*, Vol. LVI(I), 1962.

based. It was concerned principally with headquarters organisation and manning, and dealt only incidentally with force composition or operational considerations. As a follow-up, and in order to provide a similar brief on technical issues, a team of senior technical personnel went to the United States in the winter of 1960–61 to familiarise themselves with the plans and philosophy of the United States POLARIS programme, which at this stage was being rapidly expanded. The team was led by Mr. S. J. Palmer, then an Assistant Director of Naval Construction, and he, together with the other members of the group, subsequently was a member of the directing staff of the Chief Polaris Executive (CPE). Their report established many of the basic parameters used in the POLARIS programme. All of this was prudent staff-work, unrelated perhaps to the preferences of the Naval Staff, but in line with the public pronouncements of the new Minister of Defence, which clearly envisaged POLARIS as a possible, if hypothetical, successor to SKYBOLT.(7)

In the late autumn of 1962 the hypothesis moved quickly nearer to reality, as SKYBOLT's technical difficulties produced financial implications of major significance to the US Defense Department. The difficulties centred around the problems of providing accurate directional information for a ballistic missile, the launch vehicle for which was itself travelling near to the speed of sound; they had always presented a formidable difficulty, and had been known if not fully understood, at ministerial as well as at service level, for some time. Henry Brandon, Andrew Pierre, Richard Neustadt and other commentators have suggested that the intensity of the Anglo-American crisis over SKYBOLT was related rather more to a range of political factors, including the aftermath of the Cuban missile crisis and misperceptions on both sides, than it was to the particular technical dilemma.(8) Certainly, the initial *démarche* at ministerial level, when Mr. McNamara, the Secretary of Defense, discussed the position with the British Ambassador on 8 November 1962, took the form of an exposition based primarily on economic factors; the price was rising, the date was slipping, and the Secretary of Defense felt obliged to ask the Chiefs of Staff to examine the whole project. The Ambassador emphasised the political importance for the United Kingdom of the project, and the Secretary accepted that the United States would be under a continuing obligation to the United Kingdom if it were decided to cancel: he envisaged three possible alternatives, which were that the British would continue with SKYBOLT alone, that the United States would supply a similar but much less advanced system, HOUND DOG, or that

(7) See *House of Commons Debates*, Vol. 635, col. 1507 (28 March 1960) for Mr. Watkinson's statement. See also *House of Lords Debates*, Vol. 223, col. 1278, for a similar statement in the House of Lords Defence debate by Lord Carrington – the Admiralty was urgently considering "what would be involved in building POLARIS submarines ourselves".

(8) A. J. Pierre, *op. cit.*, pp. 224–231; H. Brandon, "SKYBOLT, the full inside story of how a missile nearly split the West", *The Sunday Times*, 8 December 1963; R. E. Neustadt, *Alliance Politics* (New York, Columbia University Press, 1970), c.3; T. C. Sorensen, *Kennedy* (New York, Hodder and Stoughton, 1965), pp. 564–576.

the US would supply a replacement system, such as MINUTEMAN or POLARIS.(9)

The news caused consternation in London. It was not only a very unwelcome development in itself, but it could not have come at a more fraught time. The President and the Prime Minister had already engaged to meet in the Bahamas in mid-December, after Mr. Macmillan's visit to France; there was therefore no more than five weeks to determine what the United Kingdom's reactions and objectives should be. This left very little time to consider whether a continued dependence upon American cooperation was to be preferred or whether, for example, it might be the time to advance seriously the cause of a European-based collaboration in nuclear weapon development which had, rather earlier, been aired. Militarily it was very important to try and achieve a result which would leave the smallest possible gap between the obsolescence of the V-bombers and the in-service date of whatever was now to supersede them. Secondly, it was now beyond question that the Nassau Conference would take place under tension: some questioning of American motives was bound to arise, and to be linked to the lack of formal consultation which had been experienced during the Cuba crisis;(10) critical British opinion also harked back to Mr. McNamara's Ann Arbor speech in June 1962 when he had advocated the centralised control of Western nuclear armaments, with only a slight bob towards British loyalty to the alliance. McNamara met Thorneycroft on 11 December and the US Secretary again set out the reasons for the tentative conclusion to cancel SKYBOLT: in the interim another weapon trial had taken place and had been a complete failure. Again he set out the possible alternatives, except that now the suggestion for a replacement system had altered to British "participation in a sea-borne MRBM force under multilateral manning and ownership". It looked as if the proponents of a NATO Multilateral Force, which had recently been resuscitated as a way of placating some of the allies' wish to be more closely associated with nuclear decision-taking, were getting in on the act. Mr. Thorneycroft by now had been briefed on official ideas

(9) Mr McNamara's concern was precipitated by a revised estimate of development costs to bring SKYBOLT to operational status. The original USAF-Douglas development estimate had been \$354m., and the new estimate was found to be \$493m. Operational availability had originally been forecast for October 1964, but in 1960 this had been revised to Spring 1965; and in December 1962, in a further revision, sometime in 1966 was being talked of. Five flight tests up to the end of November 1962 had all failed, for various reasons. Every major sub-system, it was claimed, had worked satisfactorily in one or more flights, but they had never all worked satisfactorily together. At the end of December 1962, a sixth flight was declared a success by the USAF, but this claim was flatly contradicted by a Pentagon spokesman (See *Aviation Week and Space Technology* for 17 and 29 December 1962 and 7 and 19 January 1963). The fact of the matter was, as both British and American press commentators noted, that SKYBOLT was no longer as important as it had been in the United States programme; the success both of MINUTEMAN and of POLARIS made it expendable.

(10) Although we know now that President Kennedy frequently telephoned the Prime Minister during the crisis, and that the Foreign Secretary took part in some of the discussions, it is not at all clear whether these conversations were formal government-to-government consultations. See H. Macmillan, *At the End of the Day* (London, Macmillan, 1973), Ch. 7.

about what should be negotiated. A group of officials, at Deputy Chief of Staff level, had considered a range of possibilities. One such was a "hybrid" submarine; a boat armed with eight POLARIS missiles and having good hunter/killer capabilities as well. This hybrid would go some way towards meeting one of the Navy's concerns that a crash POLARIS programme would effectively deprive the Fleet of a number of the nuclear attack submarines that were beginning to enter the construction programme: DREADNOUGHT was virtually complete, and VALIANT and WARSPITE were building or on order. A proposal examined in some detail was that the deterrent force should be mounted in seven such hybrids. The alternative which was also examined was to seek to purchase one or two complete US submarines, and to build perhaps three more in the United Kingdom. Both solutions would be dependent upon the availability of a suitable British warhead, since the government neither wished to be dependent upon American warheads, nor were they available to be bought under existing United States law. The conclusions on these suggestions were that the 'gap' between the V-bombers and the new weapons might be between four and five-and-half years, even with a crash hybrid programme; also it was generally felt that the new version of POLARIS, A3, was desirable, that a British warhead could be made available by January 1969, and that the manpower costs to the Navy would be severe.

The hybrid concept slowly disappeared: McNamara and the US Navy advised against it, both on grounds of cost and because it represented major engineering differences. FOSM was mildly in favour: such boats would certainly be possible to operate and the variety of function might sustain morale. After serious discussions began with the US Navy in January 1963, the hybrid sank from sight, principally because the engineering changes necessary made the weapon system non-identical with the US system, because more manpower would be involved, and because the effect of the new programme on the attack submarine programme proved to be less dramatic than had been feared. It was also the case that the hybrid lost much of its attraction in the context of a force assigned to NATO; otherwise the boats might have been used as dual purpose vessels. At least, that was a proposal that had been mooted, but it rather underplayed the absorbing nature of the deterrent function.

At the Nassau Conference itself, little time was spent on SKYBOLT: the American case for cancellation was clear enough to rule out any question of the United Kingdom going it alone. The essential issue was how far the POLARIS material provided to the United Kingdom should be made available without strings and how far it should be contingent upon participation in a multi-national or multilateral nuclear force under NATO direction. Eventually a compromise was found, with both sides representing their views in a *communiqué* that has many ambiguities.(11) During discussions the British represented the need for

(11) *Statement on Nuclear Defence Systems*, Cmnd. 1915, 21 December 1962 (London: HMSO 1962).

an ultimately independent force, and the President made the point forcibly that there was a major qualitative difference between SKYBOLT and POLARIS. The one had merely extended the life of the V-bombers, the other would prolong the British nuclear capability well into the 1980's.

The outcome of the Conference was, however, that the Admiralty and the Navy had been made responsible for the provision of a deterrent force to replace the V-bombers; the size of the programme and its shape were as yet to be determined. At the administrative level, there was a basic outline of the sort of organisation that would be required; but it was nearly three years old and unrelated to any specific programme. At the technical level there was a fair degree of general knowledge, though it was concentrated in the experience of a handful of senior officers. At the level of doctrine, there was a range of opinion but no unanimity: a certain degree of relief, perhaps, that the Navy had been given this new and important role, but a degree of concern also about the demands which the programme would create. What was quite certain, however, was that the general reputation of the Service was now at stake and involved in the successful creation of the POLARIS force.

## CHAPTER TWO

# *The Creation of the Framework*

The Nassau *communiqué* established, at a very broad political level, that the United States government would sell POLARIS weapon system equipment and spares on a continuing basis and that the United Kingdom government would use the weapon system to outfit, arm and maintain a force of submarines that would be assigned to NATO but would also remain, intrinsically, a national force. The broader aspirations of the *communiqué*, that a somewhat similar offer would be attractive to the French government and that the whole might be supportive of the British candidacy to the EEC, were not realised. The details, about what precisely might be involved, still had to be determined, and the first task of the United Kingdom government after the Prime Minister had returned from the Bahamas was to settle down to detail.

The results of the conference gave rise to a good deal of political debate domestically, which intensified after General de Gaulle's rejection of POLARIS and of the British application to join the Common Market at his press conference on 14 January 1963. Criticism of the agreement with the Americans was widespread and, so far as particular issues were concerned, extended to a questioning of the utility of maintaining any separate British deterrent force at all as well as to doubts about the utility and the cost of the POLARIS proposals.<sup>(1)</sup>

In the meantime the various government departments which were going to be concerned with the implementation of the agreement began to order their forces. The Foreign Office, the Treasury, the Ministry of Aviation, the Ministry of Defence and the Admiralty were the principal agencies involved. The Foreign Office began to consider what supplementary agreements would be required to define the specific terms of supply and sale, in consultation with the State Department: Defence,

(1) See the debate on defence in the House of Commons on 30–31 January 1963: *H. of C. Debates*, Vol. 670, especially columns 955–1079 and 1139–1260. Also *H. of C. Debates*, Vol. 673, cols. 31–164, 221–340; 15 March 1963. The efforts made by the Prime Minister and Minister of Defence, immediately after the Nassau meetings, to allay the criticisms voiced by their own supporters illustrated the degree to which opinion remained suspicious of official pronouncements about weapon costs and expenditures in the post-SKYBOLT period; see *The Times* 25 February 1963, p. 6 for a comment by the defence correspondent that "British planners have not so far grasped what the POLARIS submarine missile system really costs".

Aviation and Admiralty proceeded to elucidate what force would be required, what supplies would be necessary and what organization should be set up. As a part of this last issue, the senior staff of the organization had to be selected: already, on Boxing Day, the then Flag Officer Submarines, Rear Admiral H. S. Mackenzie, had been notified by the First Sea Lord that he would be appointed to direct the naval organisation.

An immediate requirement was to bring up to date the information and the ideas which had previously been collected. As far as organizational forms and relationships were concerned, the Le Fanu report of 1960 provided a blueprint and it was taken out to be reviewed and assessed. The basic principle on which it had been drawn up was that, whatever the formal shape of the organization was to be, there would be a need to push through the acquisition and deployment of a POLARIS force with speed and decisiveness. Admiral Le Fanu's report included an initial assumption that the programme would be an eight boat programme, spread over fourteen years using the POLARIS system with British warheads. Hence the tentative costings estimated the charge on current Navy Votes at 7% initially, rising to 20%–25% as the programme achieved its peak expenditure. These estimates did not include manpower costs of an estimated 6,000 officers and men. The core of the report however was the analysis of the alternative possibilities for an organisation to control the programme: on the one hand, a small group of directing staff, brought together to co-ordinate the separate efforts for the various divisions and departments within the Admiralty, or, on the other hand, a composite project group, hived off from their functional parent organisations, and given a distinctive identity and purpose. Admiral Le Fanu's preferred solution was to establish a strong authority in charge of the programme with a direct responsibility to the Board of Admiralty (although it would not be part of the Board). Financial control and weapon system work would be kept in the hands of such a Chief Executive and his staff. Other work would be sub-contracted out to existing Admiralty machinery with specified staff to supervise the "sub-contracted" work.

The analysis was essentially a limited one, concerned primarily with the effects of the imposition of a hypothetical responsibility within the Admiralty. It was drawn up at a time when the American POLARIS project was still at the development stage, and it did not go into any detail about what sort of linkages there would need to be with the USN. Nor did it do more than state that inter-departmental linkages would be required in the United Kingdom. Relationships with the Ministry of Aviation, both at headquarters and with outstations (particularly the Atomic Weapons Research Establishment) would need to be defined carefully; so, as it happened, would the relationship with the new Ministry of Public Buildings and Works, which was to be set up at the beginning of April 1963 and which took out of the control of the Admiralty many of the responsibilities for buildings and maintenance which had previously been the purview of the Navy Works Department. The Le Fanu report had only touched inferentially too upon the extent to which the form of the organisation would need to reflect the types of demand that would be

placed upon it, in terms of time-pressures, or budgetary constraints. This was understandable, in the sense that it had been devised for no particular situation; but it also reflected the nature of the model upon which Admiral Le Fanu's analysis had been based. He had very much in mind the type of organisation which the United States Navy had established to manage and control their own POLARIS programme: he had visited Special Projects Office (SP) in order to see how it worked and he had consulted, among other authorities, the CBNS and the staff liaison officer who had been appointed to maintain contacts with SP in October 1958. After the initial possibility of procuring POLARIS had passed away in 1960, the post had been maintained, although the direct utility of the connection had diminished by the summer of 1962 to a point at which it no longer seemed essential to maintain the post. Fortunately however the post was maintained, to be very helpful in 1963.

There were obviously very considerable differences which had to be taken into account, and Admiral Le Fanu, who had been one of the first of the new Directors General in the Controller's Department, was aware not only of the Anglo-US disparities but also of the relative novelty of the British organisation into which any POLARIS project group would need to be interpolated, or on to which it would have to be grafted. The Controller's departments had been reorganized into Directorates General, somewhat in the style of functional Bureaux, in 1958 following the report of a departmental committee under Sir Barclay Nihill;<sup>(2)</sup> but the first major new construction programme that had been started since that time had itself been organised as a cross-departmental project, to supervise and monitor the building of the Navy's first nuclear-propelled submarine, the DREADNOUGHT. For a considerably larger project, the choice seemed to be, as the Secretary of the Admiralty put it to the Board in late December, either to create a microcosm of the Admiralty, which could as a separate entity work in parallel to the Department as a whole, or to use the existing departmental machinery.

A third option was that neither extreme alternative should be adopted, and that the Board should set up a project-type organisation, on the general lines recommended in the Le Fanu report, but with some important alterations. The head of the organisation should be a naval officer, of a sufficient seniority to be on a par with the Controller's Directors-General, but with a specific remit and the authority to deal with and report directly to the Board. He should have a naval assistant (who later became CPE's deputy), in a role analogous to that of a chief staff officer: a technical staff, covering ship, weapon (and, subsequently, logistic) issues, and a senior civilian assistant, who would deal with financial, general policy and staffing matters. There would need to be a liaison staff in Washington, and well defined links with the Ministry of Aviation. It had already been agreed – at official, though not yet formally at ministerial,

<sup>(2)</sup> See *Select Committee on the Estimates, Ninth Report, H. C. 263, 1961–62. Her Majesty's Dockyards.*

level – that the Admiralty should have complete responsibility for procuring the missiles and the whole of the missile system from the United States, but this did not solve all the issues that might arise, particularly the degree of direction, or control, that the project director could exercise over Ministry of Aviation staffs.

There was an important issue too relating to responsibility within the Admiralty. The formal responsibilities of a number of heads of department included provision for duties relating to the exercise of professional supervision, maintenance of standards affecting safety or stability and the obligation to enforce these desiderata: the Directors General, Ships and Weapons were the appointments principally concerned but the Chief Inspector of Naval Ordnance and the Director of Armament Supply were also involved. Not only would it be difficult to divide or set aside these responsibilities; it might in practice be impossible to do, because of the shortage of suitably qualified personnel that could service two parallel organisations. So it was proposed that staff appointed to the Polaris Executive, as the new organisation was to be called, should be categorised in one of three ways. The head of the organisation and his immediate staff would be appointed in the ordinary way, with a unitary responsibility; other staff, with a professional obligation to, say, the Director-General, Ships (DGS) would be appointed to work in the Executive but would remain responsible for the professional quality of their work to their 'tribal chief'. They were 'allocated staff'. The third category consisted of staff who need not be allocated full-time to the Polaris Executive but who had a function to perform related to the POLARIS programme: examples might be either the designers of sonar displays in the submarines, or personnel managers whose ordinary business might extend to negotiating the terms of service of industrial civil servants in the new base. These staff were 'designated', as being connected with POLARIS but not employed full-time in the programme: they would continue to be responsible for the efficient execution of their duties to their normal head of department but they would be required to meet the needs of the Polaris Executive as well.

It was a device primarily intended to make appropriate staff available quickly without turning the whole Admiralty structure upside down, and to enable the demands and effects of the programme to be readily identified. It sounded clumsy, and looked ponderous on organisation charts but the notion of a dual responsibility was not unfamiliar, either in the Service Departments or in NATO. In the event, it worked satisfactorily and was helpful in containing some of the feeling of disquiet that there was among the Controller's departments that this novel, challenging and potentially prestigious programme was being removed out of the ordinary run of affairs. Such feelings might have been expected to emerge most readily in the Ship Department, because it became clear that the staff of the Dreadnought Project Team would constitute the core of the Polaris Executive Technical Division; they were the only group with nuclear submarine skills, in design or production, and although the interpolation of the POLARIS weapon system and all the associated equipments would

impose a very extensive range of new problems upon their expertise, there could be no question of their essentiality.

Some of them had not only been involved in nuclear design work from the DREADNOUGHT but had been associated with the initial familiarisation with the United States POLARIS programme in 1960–61. The heads of the ship and electrical engineering sections, for example, had been members of the technical mission of that period, and had been kept reasonably up-to-date in the interim with general submarine design material through the regular exchange of information arrangements that operated between DG Ships and BUSHIPS. (This routine flow of information ceased after the Nassau Agreements.) The early technical analysis of what would be involved had established a number of important guidelines, besides giving a good general idea of the interactions between the ship and the rest of the system. In particular, it had been shown that the best arrangements for a building programme would be to have submarines completing at six-monthly intervals; on the assumption that there would be two building yards, a six-monthly cycle looked good for testing and tuning, patterns of labour deployment, for crew training and commissioning, and for providing a convenient build-up to a steady operational deployment. But, in January 1963, there was an urgent requirement to ensure that these types of assumptions were still valid; the existing analysis was based on material nearly three years old, when the United States Fleet Ballistic Missile (FBM) programme did not have the same degree of priority or so wide a range of resources at its disposal. The 1960 norms had been based on POLARIS A2: if the United Kingdom was to go for the newer A3 model, up-to-date information had to be got as soon as possible to establish whether the generational supersession was of fundamental significance to the building phase and whether it might make any significant difference to the arguments relating to the size and type of force, which were still not determined.

At the beginning of January therefore, a mission headed by Sir Solly Zuckerman (the Chief Scientific Adviser in the Ministry of Defence) and Vice Admiral Varyl Begg (the Vice-Chief of the Naval Staff), and including Sir Robert Cockburn (Chief Scientist at the Ministry of Aviation) Mr. J. M. Mackay (Deputy Secretary of the Admiralty) and Rear Admiral Mackenzie went to Washington to be briefed on the current and future state of the POLARIS art, and to acquire as much information as possible on which decisions about the new programme could be based. Information relating to a whole range of issues had to be acquired. The two most significant were how many submarines and how many missiles to submarines to procure. At the time, a force of five or six submarines equipped with sixteen missiles each was emerging as the preferred Naval Staff view, in succession to the earlier suggestions about a larger force of 'hybrid' submarines with fewer missiles. The mission also had to learn what it could about the new mark of missile, the A3. More mundane but equally important areas of knowledge, in terms of eventually securing the success of the procurement exercise, included the extent of the supplies, the logistical support and the other assistance that would have to

be acquired from the United States, and the best way of providing it at lowest cost: what would be necessary in the way of modifications to United States equipment to make it compatible with British submarines: and what would be the relative advantages and disadvantages of substituting British equipment or components for those of United States origin, bearing in mind the time constraints likely to be set for the programme. Finally, the mission had to be briefed on what were the communication and navigational requirements, especially in the context of ensuring the independent control and operation of the British fleet.

It could not have been a more difficult time in which to be pressed to take major decisions relating to the third attempt to maintain the deterrent force. The desirability of opting for the latest model of missile could be fairly easily established – if it worked. A3 was still not proved, and if the prime virtue of acquiring POLARIS was that the United Kingdom was buying a system that already worked, there was something to be said for going for the A2. To depend upon A3 was to rely entirely upon the commitment of the Special Projects Office to make it work.

The second area of uncertainty was in nuclear propulsion. HMS DREADNOUGHT was virtually complete: but she was powered by a Westinghouse reactor of American design. The British design of power plant, which was to be used in the VALIANT class, and by implication in the POLARIS submarines, was not yet proved. Experience of installation and nuclear submarine construction was limited to the Vickers Yard at Barrow-in-Furness, and the one case of DREADNOUGHT; and it was virtually certain that Vickers would have to take on additional responsibilities as a lead yard.

## CHAPTER THREE

# *The POLARIS Sales Agreement*

One of the most urgent requirements in the early months of 1963 was to determine how and in what way the general agreement reached at Nassau should be made specific. In earlier cases of bilateral agreements about purchases of major equipment – for example those relating to SKY-BOLT or the Westinghouse reactor for DREADNOUGHT – the arrangements, either between governments or contractors, had been made as a consequence of detailed negotiations in which both sides had developed a relatively clear idea of what was at issue. The deal was done as the culmination of a process of elucidation and agreement stretching over weeks, and even perhaps months. In January 1963 the position was different: an agreement in principle had been reached quickly and under tension, without the intervening stages of preparation. Neither side could be precisely sure what might be involved, although both sides were required to produce an agreement that gave form to the settlement that heads of government had laid down.

On the United States side, the Special Projects Office had been only on the fringe of preparations for the Nassau Conference; they had provided information to the Secretary of Defense but had not done so with any appreciation of the likelihood of the eventual outcome.(1) The Pentagon had made sure that President Kennedy was well briefed on the POLARIS option and a good general level of information was available on possible force levels, costs and time-scales – though it had been got together hurriedly after the November consultations between McNamara and Thorneycroft.(2)

The British briefing was of a similar sort, and it was not until after Nassau that the fleshing out of detail began. By the middle of January, the Foreign Office was in conversation with visiting American officials and by the end of the month, the State Department sent across to London the text of a preliminary draft. Even before that, British missions under Sir Solly Zuckerman and Vice Admiral Begg at the policy level and at the technical level under Mr. R. J. Daniel, then the Chief Constructor in charge of the ship design group in the DREADNOUGHT Project Team,

(1) Interview.

(2) Interview.

had been to Washington to reconnoitre. They met officials from the Defense and Navy Departments, and from the Atomic Energy Commission (AEC), as well as from the State Department in early January, and the Begg-Zuckerman report was available by 15 January. It highlighted several important points. Special Projects Office had strongly urged a British system as closely related to the FBM system as possible: nuclear submarines with a battery of 16 missiles; no surface ships, no hybrids. Identicality was one of the keys to a speedy transfer of information and assistance. SP also advocated purchasing the A3 missile; they were emphatic that it would be successful, and warned that the A2 missile production lines were planned to close down within the next two years or so. The mission also learned that the Secretary of Defense was proposing to levy an R & D surcharge on the purchased equipment. A satisfactory agreement was only eventually reached after the British Ambassador had suggested to the President that a percentage levy should apply only in respect of development costs incurred after 1 January 1963: in other words that there should be no explicit contributions to the basic R and D costs of the earlier parts of the FBM programme.<sup>(3)</sup> The impression was gained early on, then, that the detailed financial terms would be toughly contested.

The "deep technical mission" brought back some useful and specific information, which effectively brought up to date the information available from the 1960-61 exchanges. They identified the scope of the initial problems which the Admiralty in particular would be facing, the plans that it was necessary to ask for to begin submarine design work, and the need to set up a programme for equipment procurement that extended to ship fitted equipment available only through the Electric Boat Division of the General Dynamics Corporation, which was the USN's lead shipyard contractor, at Groton, Connecticut.<sup>(4)</sup>

In the same timescale, the United States sent officials to London: besides Mr. Paul Nitze at the ministerial level, a group of officials from the Special Projects Office. So, by the time that the State Department draft was received, a series of visits had provided enough information to allow a formal negotiation of detailed terms and arrangements to be set up: on 17 February, the British party left for Washington. It was led by Mr. J. M. Mackay, and comprised besides Admiral Mackenzie, officials from the Admiralty, Ministry of Aviation and Ministry of Defence. In Washington they were assisted by Embassy staff, including legal experts. The terms of reference and negotiating brief were drawn up after inter-departmental consultation and, in general, gave Mackay a good deal of latitude; it was clear, however, that there were likely to be a number of difficulties. The most obvious were the specific financial terms, where McNamara's insistence on some sort of R and D levy gave a hint of the distinctions likely to be drawn between generosity and munificence.

<sup>(3)</sup> This compromise was suggested to the Ambassador by the RN Liaison Officer in SP. See the comment by Pierre, *op. cit.* p. 242.

<sup>(4)</sup> Interview.

Secondly, it was clear that the US Government would endeavour to relate this particular transaction to its general policy on equipment sales which was currently being evolved; this might in part be acceptable if it eliminated the need for specific Congressional scrutiny, but the Minister of Defence and the Foreign Office were already sensitive to any attempt to rewrite the Nassau understandings in some more general way which would commit the UK to a multilateral nuclear force or a general NATO-wide initiative.<sup>(5)</sup> Thirdly, although it would be desirable to specify clearly what the agreement was to cover, not least because of the requirements of existing domestic US legislation and US-UK bilateral agreements on nuclear materials and information, it might be difficult, in the existing state of British knowledge, for the team to be sure how precisely the full needs of the British programme should be covered, given that the understanding at Nassau was to make a continuing agreement that was going to last long beyond the construction phase. Allied to this was the need to provide machinery to make the cooperation that would be necessary effective.

The United Kingdom team was made up, in large part, of officials who would be closely involved with the working of whatever could be agreed, and the United States negotiating team, although it was much larger, as "home teams" usually are, followed the same principle. The chairman was a distinguished Service lawyer, Admiral Mott, but the bulk of the party came from Special Projects Office. The AEC and the Office of the Secretary of Defense (OSD) were also represented. Formal plenary sessions between the two groups began on 22 February and were interspersed by smaller bi-lateral meetings as well as national briefings. The United Kingdom team reported progress by telegram to London and, as the difficult areas of negotiation became evident, by telephone. The United States side had a degree of latitude in proposing features and conducting the discussions which illustrated how heavily Special Projects influenced US Government objectives: only in one area, that relating to finance, was the hand of OSD apparent.<sup>(6)</sup> The Director of Special Projects, Rear Admiral I. J. Galantin, was very much aware of the obligation to create a workable and successful agreement; it was not only an obligation of honour deriving from the Nassau Agreements, but a desirable aim for Special Projects Office itself, to sustain and amplify its record and its reputation. But on the other hand, the American national programme had to be protected; A3 was not yet proven, and the extensions of the FBM programme authorised in 1961 by President Kennedy from 14 to 29 and then to 41 boats were shortly to lead to an intensive ship-completion and system-proving period when, for nearly two years, one submarine a month would join the fleet. The interpolation into this situation later in the year of the THRESHER disaster, with the possibility of urgent and critical shipbuilding alterations, merely heightened SP's concern to ensure that the United Kingdom programme - whatever it turned out to be

<sup>(5)</sup> See Pierre, *op. cit.* pp. 243-251.

<sup>(6)</sup> Interview.

– should not delay or otherwise intrude upon the FBM schedules.(7) Consequently the negotiations, and the shape of the provisional agreement, evolved around the SP input. This was nowhere more clearly shown than in the discussions about the right to manufacture equipment.

The British were concerned to acquire a sufficient level of information to give them an opportunity to manufacture equipment in the United Kingdom. The reasoning behind this was not only to assert a capacity to maintain independence but, more evidently, to save dollars: where equipment was of a more or less standard type, why not have it made in Britain? Admiral Galatin, strongly urged by Admiral Levering Smith, the Technical Director of the FBM programme, opposed this view. There was a political overtone; the United States negotiators had to take account of the possibility of domestic criticism that the deal had been too generous: American jobs might be lost, patent rights transferred and so on. More fundamentally, Admiral Smith argued that the philosophy of a successful deterrent system depended crucially upon a validated assurance that the system would operate successfully if required. This rested, not upon regular and frequent test firings such as might be possible for conventional artillery, but upon the quality and the reliability of the installed equipment, monitored continuously and made identical to the greatest possible degree in each class of ship.(8) If the USN assumed the responsibility to provide a working, and proved, system, the Royal Navy would be able to check the performance of its own ships through the body of reliability data that the US programme was steadily accumulating. This would be a very clear, and great, advantage. On the other hand, to provide the technical and engineering support to ensure the quality and reliability of any modified parts in a small programme of four, or perhaps five, boats would be extremely costly and would reduce the perception of reliability upon which the system, as a deterrent, was based. It was a difficult point to negotiate, because of the sensitivities on both sides and because it involved, for the British, a dependence on the capacity and intentions of SP upon which they were not yet in a position to rely. The definitions about what constituted the essence of the “joint programme” had consequently to be carefully drawn up,(9) but was successfully achieved; the realisation that the additional programme of direct procurement from the Electric Boat Company that would be necessary would cut down the area of interface definition around which this issue revolved was of assistance here, in reaching agreement and in adding impetus to the conclusion of a contract between the Electric Boat Company and the Admiralty.(10) The definitions of what constituted the POLARIS system

(7) Interview.

(8) The practice in the FBM programme in relation to test firings was for each crew to fire practice missiles during final proving trials and after refits, and only rarely at any other time. Only one firing has ever been made of the complete launch-to-explosion sequence of an operational missile.

(9) For example in Article 3 of the *Polaris Sales Agreement, Cmnd. 1995*, April 6 1963; see Appendix I for the text of the Agreement.

(10) Interviews.

so far as the “joint programme” was concerned also had to take care not to include the missile warhead or the nuclear propulsion system but to define the interfaces in a way that would allow British equipments to fit and to function.

It was perhaps inevitable that the size of the task of interpreting the Sales Agreement should be underestimated but quite early on in the negotiations, the two sides agreed that the level of detail that could be foreseen would require some ancillary documentation. They therefore devised the “Technical Arrangements”, which were to be procedures and definitions, jointly agreed, relating to specific issues or problem areas and intended to be of use at the working level. This formula proved to be of great significance and eventually became the standard mechanism for defining and then resolving what specific management problems were and how they could be handled. Technical Arrangement sections were negotiated, approved by the Project Officers, and promulgated throughout the joint programme management structure.

By the end of the first week in March, a good deal of detail had been covered in the negotiations, and provisional agreement reached on many points.(11) The main area of difficulty remaining was the financial terms. It had already been accepted by the Prime Minister and the President that a surcharge should be paid, to provide a contribution of 5% towards R & D costs; it was to be limited to equipment coming into service after 1 January 1963, which meant in practice that it would only be paid by the United Kingdom if the A3 missile was chosen. If A2 was chosen, no R & D levy would arise. This surcharge was to be limited to equipment costs, and would not be levied on services. An R & D surcharge was normal practice in equipment sales – and the standard UK charges at the time ranged from 7% to 14%. During the Sales Agreement negotiations, the United States side argued that British orders of equipment should be tied in with American orders wherever it was practicable to do so: not only would some financial benefit be likely to accrue to both sides from larger batch ordering, but there would be less likelihood of clashes of priority that would impede either national programme, and the whole business of inspection and test would be easier. This would however also mean that United Kingdom orders for equipment would have to be determined by timescales that were related primarily to United States needs; in the early months of the programme it meant that CPE was dependent heavily upon SP advice about what was necessary (and it created, as we shall see, considerable problems, not least in learning how to work the administrative system which SP had evolved). It also meant that, on occasion, orders for United Kingdom equipment were placed before they were strictly necessary: and this not only created some difficulties with the Treasury but required extra expenditure for storage. The provision for common contract ordering also threw into sharp focus the need to have a procedure for allocating costs. If the United Kingdom orders had been entirely separate, the identification of costs would have depended upon

(11) For example in Articles II, IV, V, VI, VII, VIII, X, XII, XIII and XV.



the type of contract employed and a fairly standard accounting procedure. The common contract formula required some sort of adjustment, and it was in this aspect of the negotiations that Mr. McNamara laid upon the United States negotiating team specific requirements that resulted in an average cost adjustment formula. Briefly, this provided that costs incurred during the initial building phase (of the British programme) should be allocated according to a formula that would operate over the whole building programme, 1963–69, and that provided for a series of adjustments to be made not only during each successive financial year but at intervals until all attributable costs had been identified. The purpose of this provision was to ensure that the British would pay a price which included some part of the cost of more expensive orders placed at the beginning of a production run; but it was extremely complicated and, the British said, unworkable: more suitable for Chancery lawyers than for financial managers. The Americans privately agreed, publicly explained how they hoped it might work, and both sides relegated to their financial experts the duty to live with it as best they could.<sup>(12)</sup> The United Kingdom team accepted this position because they still had to take into account the possibility that the British government would decide to go for the A2 missile: this might well involve the resurrection of a special production line, and in that event average cost adjustment might be a very beneficial arrangement.<sup>(13)</sup> More important, in political terms, was the demand – also stemming from OSD – for lump sum payments as a contribution towards increased United States overheads. It was undeniable that the interpolation of the United Kingdom requirements into the FBM programme would create extra work: at head office, in the factories, the training establishments and test ranges, and in the storehouses. It was also undeniable that it was common practice in all inter-governmental dealings to make some sort of charge for this type of cost. It nevertheless came as something of a surprise for the British negotiators to be told that specific sums – originally totalling \$36 million – were to be attributed to these functions; it looked very much as if McNamara wanted to get back by this device the money which he had 'lost' by the settlement on a 5% R and D levy. Prolonged discussion produced a formula by which \$17.5m might be attributed to depreciation and overheads, while the rest of the original sum was said to be 'adjusted' in the levy charges. The Americans could not be pushed further. On 6 March therefore, Mackay reported the *impasse* to London, asking for instructions on this and on some other points. On 13 March, the Minister of Defence reported the views of himself and his colleagues to the Prime Minister; he drew attention especially to the concern which the United States government was showing about establishing precedents *vis-à-vis* their Multilateral Nuclear Force (MLF) proposals, which were then at a high point of activity. Mr. Livingstone Merchant and Admiral Lee were even then touring the NATO European capitals, extolling the virtues of the MLF

(12) Interviews.

(13) Interview.

concept. With the agreement of the Prime Minister fresh instructions were sent to Mackay, who resumed negotiations on 15 March.

The negotiation of the POLARIS Sales Agreement provided an important learning process, especially for the staffs of the officials who, under the terms of the Agreement, became the Project Officers. The SP team were brought into contact with the requirement that had been laid upon them by the Nassau understandings, and, from the first, explored its ramifications jointly with their new partners. The British team, though it was much smaller, and varied from time to time, as various members had to return home to cope with all the matters of basic policy which were being hurried forward to define what the United Kingdom programme was to be, shared in this process and could not but be impressed by the zest and the evident good intentions of their American counterparts. The dominating personality in the negotiations was J. M. Mackay.<sup>(14)</sup> Physically very tall and impressive, ostensibly dour, and absolutely determined to achieve the best possible result, he was at times as much an enigma to his colleagues as to his negotiating adversaries. There was little in the way of collective discussion in the United Kingdom national briefings: Mackay would keep his own counsel about his objectives, say what he wanted done in the way of detail and go on to negotiate in the plenary sessions with a mixture of bluntness and shrewdness which consistently impressed the Americans and occasionally puzzled his colleagues about what had to be done by way of follow-up action. It was a masterly performance and was a major factor in producing a text which went into great detail, and left no ambiguities except in areas where both sides agreed precision was not possible. The length of the negotiating period, considering the force and clarity of the political fiat, reflected the complexity of the task, and the thoroughness of the negotiations on both sides.<sup>(15)</sup>

The one area in which it might be said that the negotiators were unable to provide adequately for future needs was finance. The Sales Agreement was explicitly recognised as a continuing agreement, but the average cost adjustment formula, and some crucial parts of Article III,<sup>(16)</sup> heavily emphasised the initial period during which the United Kingdom force would be built and brought into service; there was an implication – but not a very clearly signposted implication – that new arrangements might then need to be made. The financial specialists on both sides realised this,<sup>(17)</sup> and the Project Officers came to realise it fairly early on; but both sides also recognised – implicitly – that in the circumstances of 1963, it would be difficult to forecast with any accuracy what the needs of 1970 and later years were likely to be; the United Kingdom programme was still not officially defined, and the state of the United States prog-

(14) Mr. Mackay was then a Deputy Secretary in the Admiralty, but subsequently became a Deputy Secretary in the Ministry of Aviation; he was knighted in 1966.

(15) Interview.

(16) For example, the last part of paragraph 1 and paragraph 2(e) (i) and (iii); see Appendix I for the text of the Agreement.

(17) Interviews.

ramme as it might have been developed by 1970 was still a matter of conjecture.

A provisional text of the Sales Agreement, largely agreed but still with some points reserved by the British delegation, was available in the third week of March. The teams dispersed, and on 29 March Mackay submitted a formal report on the Agreement and the negotiations. He reviewed the text and recommended, in general terms, its acceptance. He drew attention to the references which still remained to legislation and earlier agreements. The Americans still wanted to keep a reference to the Foreign Assistance Act of 1961 in the preamble, and although neither the Foreign Office nor the Ministry of Defence liked the insertion, it would probably make no difference to the operation of the Sales Agreement. (Ministers accepted this position, but still wished to omit it, and on the Prime Minister's representation it was removed from the final text, which refers only to the Nassau conference documents). He drew attention to the limitations which it was proposed to accept on the transmission of information to manufacture equipment in the United Kingdom, and urged that it should not be regarded as a sticking point. He also commented upon the provisions of Article XIV (1) about transference of information to third parties. Historically this type of limitation had been a common feature of specific exchanges of information between the two governments in the period since 1948, but (and here Mackay had the Multilateral Nuclear Force proposals in mind) the general climate might be changing and the UK delegation had reserved its position. The situation in the negotiations had been difficult for both parties. The implicit point being made here was that if POLARIS information was to be made generally available to NATO allies under some MLF concept, the British government would not wish to be automatically excluded from any benefits, either in more generous financial terms or even in manufacturing contracts, that might become available: but, given the thrust of United Kingdom objections to the MLF, it did not want to be seen to acknowledge that the MLF concept might be likely to succeed. (Ministers agreed to let the wording stand.) The First Lord circulated Mackay's submission to his colleagues, and the Minister of Defence held a meeting on 3 April, which sent forward a minute to the Prime Minister: Mr. Macmillan queried a number of points, most substantially about the preamble: and after a final flurry, the Sales Agreement was signed in Washington on behalf of the British government by the Ambassador on 6 April; and a subsequent exchange of formal letters explicitly acknowledged the continuing nature of the obligations which it described.

## *The Organisation at Work*

### **The early months**

Meanwhile, the organisation to take responsibility for the British programme was being set up, and being pressed, on all sides, at least to identify the major problems which would need to be faced. The Le Fanu 'blueprint' provided a starting point, but it did not help very much in determining the shape of the organisation outside the Admiralty or in selecting the personnel. Admiral Mackenzie was given a skimpy initial briefing on the aims of the programme as conceived by Ministers and the Board: and accompanied Begg, Zuckerman and Mackay on their January fact-finding mission. On his return, and in the interval before departing again on the Sales Agreement negotiating team, he began the process of setting up programme aims by discussion and argument. He was inhibited in this until his appointment could be announced, and the organisation identified to the rest of Whitehall. There were major difficulties about this, relating to the position in the programme of the Ministry of Aviation. The MOA was responsible for aircraft and guided weapon procurement; they had therefore been the responsible government agency for the SKYBOLT programme. Normally the Admiralty would be responsible only for the procurement of ships and ship-installed equipment; in the SEASLUG programme for example the department's responsibilities in the equipment field were limited to the launcher and the guidance radar. There were a number of reasons why this traditional division of responsibilities needed to be altered for POLARIS. The extent to which the ship and the main weapon system were integrated into a single system concept was greatly enhanced, not least because the ship was a submarine embodying many constraints not normally present in a surface vessel; the urgency to complete the programme indicated a project-type organisation; the analogy with the management of the United States programme pre-indicated Admiralty primacy. And the fact that – to a great extent – the programme was based upon existing hardware cut down the extent of the role that the Ministry of Aviation might be expected to play. It would be wrong however to belittle the importance of the Aviation role: statutorily they bought the missiles (using standard reimbursement procedures for transferring the costs to Navy Votes on

issue) and they had to ensure that the interface between the missile and the British re-entry system (which had to be designed) was adequately provided for. This was the part of the United States system for which it was already clear the British government could not, by US domestic law, buy very much equipment or information. By the end of December 1962 Admiral Le Fanu had got a working agreement with his opposite number in the Ministry of Aviation that the Admiralty should have effective responsibility for procuring the missiles and the whole of the associated system equipment except the re-entry system and would be the design approval authority. Mr. Julian Amery, as the Minister of Aviation, was inclined to disagree. The SKYBOLT scars were mollified somewhat by a careful courtesy on the part of the First Lord, Lord Carrington, and a full Aviation representation on the battery of ministerial and inter-departmental committees set up to assist the Polaris Executive.(1) The Ministry agreed to appoint a project officer to co-ordinate MOA and AEA activities in support of the programme. The formal creation of an organisational framework did not end difficulties between the two departments, or between their representatives in the programme. POLARIS was very much less salient in the Ministry of Aviation's programme than it became in the Admiralty, and it was sometimes difficult for the Polaris Project Office there to marshal resources as CPE became able to do. Admiral Dossor's team were also operating in an extremely sensitive area, where neither SP nor CPE held much sway, and where very precise, and sometimes very ponderous, guidelines for the exchange, handling and use of information had to be observed. In a later period, the setting up of a Joint Re-entry System Working Group provided a mechanism of substantial importance for handling the exchange of 'restricted data' information and materials which could not be processed under the term of the POLARIS Sales Agreement. The difficulties that did persist however reflected no divergence about objectives, and no lack of willingness or effort to succeed.

Within the Admiralty there were difficulties also. The design of the British submarines and the management of their construction and testing clearly called for staffs of high calibre and, probably, substantial size. On the design and ship production side, it could only mean that the bulk of the DREADNOUGHT group should be transferred: but that raised the

(1) Although it was several months before the supporting Committee structure was complete, the principal elements were (a) the Polaris Interdepartmental Policy Steering Committee, chaired by the Secretary of the Admiralty, and comprising representatives from Admiralty, Aviation, Defence and Treasury, (b) the Polaris Committee (later the Polaris Policy Committee), composed of Admiralty officials at sub-Board level, chaired by the Assistant Chief of Naval Staff, and required to deal with major issues of policy including any conflict of priorities or "any case where (CPE) finds himself unable to take or ensure measures for the timely completion of the . . . programme", and in 1965 (c) the Polaris Operational Planning Steering Committee, which was to supervise the orderly transfer of planning responsibility to the Operational Commander, and included representatives from the Home Fleet and Submarine command. In addition regular meetings were held, in 1963 and 1964, between the First Lord and the Minister of Aviation, to review progress on the programme.

question of absorbing the SSN programme as well. Insofar as only Vickers Shipbuilding at Barrow had experience of nuclear submarine work the entanglement of the two programmes was inevitable; but it represented a serious blow to the Director General, Ships who saw many of the most exciting professional tasks in his department being siphoned away, and was quite naturally concerned that a lot of his best people were being drawn away as well. The situation in respect of the responsibility for the SSN programme was not resolved until June 1963 when CPE was formally given the responsibility for the management of the hunter-killer submarine construction programme. Admiral Le Fanu was in no doubt at all however that Rowland Baker ought to be the Technical Director of the POLARIS work as he had been of the SSN programme, and Sir Alfred Sims generously supported the decision. Mr. Baker had been head of the DREADNOUGHT Project Team (DPT) since its inception and commanded not only the services of a very capable group of professional and technical staff but their loyalty and – more often than not – their affection. He was a figure of considerable stature, not merely professionally, but in personality. Mildly irresponsible in speech, and occasionally tactless, his dynamism and his firm grasp of essentials made him a colourful and occasionally controversial figure: invigorating to work for and, just occasionally, difficult to clear up after. His experience in nuclear ship design and construction made him well aware of the sort of problems that would arise, not only in working under pressure of time, but also in inducing the achievement of new and taxing standards in design and production. He held the view, which the experiences with DREADNOUGHT had reinforced, that there was a much greater and more direct relationship between ship design and ship production than the formal organisation – the distinction, for example, between the Director of Naval Construction and the Director of Naval Ship Production – implied: designers had to "lap over" into the production field because of the necessity to ensure that their intentions were understood, and to prove that their designs worked. This was increasingly important as the dependence of the whole design upon the efficient working of all the crucial but discrete components became more evident, and was a vital element in achieving the best possible "cradle to grave" maintenance. Especially for a deterrent weapon system reliability was the key function.(2)

On the weapons side there was no group comparable to the DPT team that could be hived off from the Directorate-General of Weapons; it had to be assembled by drawing in, to form a new organisation, a substantial proportion of the Navy's missile engineers and ordnance specialists. The officer chosen to head the group was Captain C. W. H. Shepherd, whose involvement in missilery went back to the early days of SEASLUG;(3) he had been a project and trials officer throughout all the development

(2) Interview.

(3) In April 1956, the infant SP had asked for British assistance, derived from their experience with SEASLUG, in evaluating the advantages of employing solid fuel rocket motors.

stages and had therefore a fairly detailed background in solid fuel technology and launch and guidance problems. He had been to the United States on the first major technical mission in 1960 and had also accompanied the Begg-Zuckerman mission in January 1963. He was therefore well equipped; but he was one of a relatively small number of technically trained officers who either had direct knowledge of the POLARIS system or who could guess at the size and complexity of the new task; and he had a relatively hard task to persuade the Director-General, Weapons (DGW) of the need to delegate the responsibility, and to accept the loss of function from the parent organisation. DGW was anyhow in harder case than DGS, who had already partly "lost" the DREADNOUGHT project; DGW could not but be perturbed by the transfer, at headquarters and from the Fleet, of a significant number of officers with missile, principally SEASLUG, backgrounds, and by demands for relatively high numbers of technical and drawing-office staff, who were anyway in short supply. For many months Captain Shepherd had a good deal of difficulty in arranging personnel transfers, in quality no less than in quantity, and was driven to use rather more technical and drawing-office staff from contractors' resources than he might otherwise have wished.(4)

To a certain extent, however, the ship and the weapon areas represented a relatively simple problem, of how to use, albeit in a novel way, structures and resources which already existed within the Admiralty organisation. In the logistics area, a structure had to be created. On one side, the Naval Stores, Armament Supply and Victualling Departments already existed, to be sure, but as separate entities, with very little in the way of co-ordinating (or controlling) mechanism below the level of the Fourth Sea Lord and the Board. The system worked well enough for internal purposes, although the Fourth Sea Lord and the departments themselves were moving towards closer and more formal inter-relationships; not only did they feel that efficiency would be improved by so doing but new developments, like the introduction of large computers, pointed the same way. Insofar as buildings, machinery and maintenance problems were concerned, there was now a formal departmental gap to be surmounted: the Director General of Dockyards and Maintenance covered a range of responsibilities in these areas, but the old Navy Works Department was in the process of transferring to the new Ministry of Public Buildings and Works (MPBW), which was to be set up on 1 April 1963, and it was by no means clear what effect this would have – except that it would require relationships more in the nature of formal negotiations rather than simple departmental direction, even with the familiar personalities and structures that were transferring to the new Ministry, where they would be smaller fish in a much bigger – if more homogenous

(4) Interviews. The provision of draughtsmen and technical staff was a particular bugbear until the middle of 1964. The employment of drawing-office staff from civilian contractors was accepted by the local Whitley machinery because of the general shortage of suitably qualified people. It was a useful and important innovation at the time, but it inevitably led to some loss – or at least the perception by some of Captain Shepherd's staff officers of some loss – of technical authority.

– pond. For all of these reasons, the Fourth Sea Lord strongly urged the appointment of a Polaris Logistics Officer (PLO), who would draw together these strands and provide a focus to ensure that planning for the provision of adequate material support did not lag behind the rest of the programme. An Engineer Captain on the point of retirement was selected to fill the post;(5) this caused some initial resentment among the Supply departments, which had already allocated staff to work with and for CPE, and which naturally had a preoccupation with their own part of the function. As it happened, however, Captain Bomford was not only able to overcome these transitory feelings by his vigour and by the support he was able to marshal for the Supply departments' needs, but was glad to rely upon the cohesion and professional competence of his civilian colleagues in the supply area, which allowed him to concentrate mainly upon the less well-organised and almost totally novel function of designing and building a new base. The concept of the PLO was a major variation from the "Le Fanu blueprint", only partly occasioned by the MPBW reorganisation; it filled a gap in the Admiralty organisation and was seen by the Fourth Sea Lord as a desirable principle in itself, apart from the need which could be attributed to the urgency of the new programme. It was followed quite quickly by a major reorganisation of the Supply departments and in this sense could be said to have precipitated moves which had been under discussion for some time.(6)

The ship, weapon and logistics groups constituted the core of the technical directorate, and were all, logically, situated in Bath where most, if not all, of their parent or associated organisations were already housed in the Admiralty complex, spread over three main sites, that had been set up as long ago as 1938. An obvious question to be dealt with was, therefore, whether Admiral Mackenzie and the other parts of the Executive's staff should not also be in Bath. If they were not, then it was possible that the cohesion of the Polaris Executive as a corporate grouping might take longer and be more difficult to create; but there was as yet no available accommodation where they could all be sited together. This was eventually to be created, by building a new single-storey block of prefabricated offices at Foxhill, on the south side of Bath, into which all of CPE's Bath staff were moved; it facilitated the maintenance of consistent and rigorous security standards as well as a sense of identity but it was not finally occupied until February 1964. Equally, if the staff was to be split between London and Bath, senior officials in particular would have to accept a good deal of travel between the two places; but this was already a fact of life in the Admiralty generally and would not be a feature special to POLARIS. In any event it was less of a burden than the other travel commitments likely to be necessary between Bath and the prospective shipyard and factory sites.

Neither Admiral Mackenzie nor the Controller had any doubt but that CPE himself should be in London. He would need to be in regular contact

(5) Captain Leslie Bomford.

(6) Interviews.

with Board members and Ministers, and to be available for inter-departmental business. Although his direct responsibilities for operational matters were negligible, CPE would have an important job to do in helping to define operational objectives and parameters: and the Naval Staff divisions and the Ministry of Aviation headquarters were all in London too. Admiral Mackenzie saw himself as the focus through which CPE's needs as an organisation were expressed – in this sense he was Bath's London spokesman – and through which also the government's requirements were specified to the Polaris Executive – in this sense he could act as Bath's London guardian against interference; besides which it became clear early on that although quite unusually specific directives about the priority to be accorded to the work had been issued, it was going to be necessary continuously to keep this sense of urgency alive in the minds of busy Ministers and officials, who had many other things to do, and who had very little real understanding of the scope or complexity of the undertaking which had been set in train. Indeed, at less senior levels, there was no awareness at all of what was going on, at least until the publication of the senior appointments and the distribution of office memoranda, in the middle of February 1963.

CPE's own office was, therefore, set up in the London part of the Admiralty, initially in two rooms and a closet: the Admiral and his secretary in one room, the typist in the closet and everybody else in the other room. Cheerful, bustling chaos ensued for a couple of months until more extensive accommodation could be found, and could only be born because for a substantial part of the time a proportion of the staff was at meetings or on visits, with the result that space at one of the four desks became available. The Principal who was to assist the Chief Administrative Officer arrived in time to see Admiral Mackenzie for twenty minutes only before CPE set off with Admiral Begg to Washington: and it was nearly three weeks before the Principal and the Assistant Secretary to whom he was to work managed to contrive an hour together to make their plans. Innovation could hardly have been said to have begun in these circumstances, but it was the starting point for a sense of commitment, and of involvement, that reflected a similar determination in the Bath office. Eventually, it became too a sense of unity, between London and Bath and between CPE and SPO, that was one of the most pervasive impressions left on the minds of the staff who worked in the organisation. POLARIS was new, and working in the Polaris Executive was novel, exciting, urgent and absorbing.

The London office came, after that febrile start, to consist of four sections. The Admiral's office consisted of his personal staff: a Commander of the Supply and Secretariat specialisation, the Project Security Officer and a clerk/typist. The Naval Assistant was a senior Captain, with a staff of Commanders covering functions relating to crew manpower and training, liaison with FOSM and the Naval Staff, and to the development of plans and programmes. An Assistant Secretary acted as Chief Administrative Officer, responsible for the provision and support of civilian staff, and for the financial management of the programme, as well as for advice

on general policy.(7) The fourth section was added somewhat later with the appointment of an American liaison team, paralleling the setting up of a British liaison office in Washington, after the coming into force of the POLARIS Sales Agreement. The Chief Administrative Officer's section provided common services for the office, including the staff for programme evaluation and monitoring, and for staffing the regular Joint Steering Task Group meetings and Technical Arrangement drafting. At its peak in 1966, the London office totalled 38 people, the Bath office, including security and typing staff, 430; the MOA project staff totalled 5, and the Washington office 31. These totals included 'allocated' staff in, for example, the Navy Contracts and Navy Accounting divisions, but not those 'designated' staff whose concern with the POLARIS programme was not full-time.

The first major activity to be faced was the delineation of the shape of the programme. As a matter of construction philosophy the Technical Director urged that there should be maximum standardization, both in relation to United States equipment and between the individual British boats. This would be important not only in design terms but also to achieve the best possible standard of maintenance while the vessels were in service. It was suggested at this time, that VALIANT, then under construction at Barrow, should be reconstructed and enlarged, to become the first British SSBN on the analogy of the first American POLARIS submarine, the U.S.S. GEORGE WASHINGTON which had been similarly redesigned. The Technical Director strongly opposed the proposal and it was dropped.(8) It might have got the first submarine to sea a little earlier, but it would have been at the cost of a good deal of shipyard and drawing-office effort and at the risk of providing a heterogeneous squadron. VALIANT was important as a first-of-class hunter-killer submarine, on which future construction was to be based, and she was to be powered by the first nuclear propulsion unit of British design and manufacture. This design had to be proved as soon as possible, not least because it would be embodied in the POLARIS boats, and insofar as weapon system design details for the missile sections of the submarines would take some time to be produced, there was no point in holding up work in hand either at Vickers, at Dounreay or at Rolls-Royce and Associates. At the same time, the question of continuing with WARSPITE, the second boat of the VALIANT class, was first raised. WARSPITE had been ordered but shipyard work was not so far advanced that the ship could not be laid aside, and it was already possible to foresee that there might be problems in relating work on this contract to the POLARIS work at Barrow. (This later became a major problem: see Chapter Seven.) The Naval Staff naturally wished to keep the boat in the construction programme, but the decision, at this early stage, that she should hold her place was largely

(7) Mr. R. N. P. Lewin, who had extensive experience of inter-governmental material and financial agreements. The Naval Assistant became CPE's deputy in 1964, after Admiral MacKenzie had been ill for a period that coincided with a major intra-departmental wrangle over the selection of navigating equipment (for which, see below).

(8) Interview.

because of the labour imbalance that would occur at the building yard if work were stopped on her before labour could productively be transferred to POLARIS construction. It was already clear, from the information gathered in 1960–61 and since Nassau, that a six month production interval for SSBN's in two streams was a logical pattern of work, derived from the demands of testing/maintenance/refit cycles and economic labour loadings, but the number of boats, and the choice of building yards was not yet settled.<sup>(9)</sup> Preliminary discussions, at the time of the Begg-Zuckerman mission indicated that a force of four, or even better five, submarines would give good value for money in providing a force at sea that would meet the government's need for an adequate deterrent force. In subsequent discussions, a decision was taken to go for four boats in the first instance, and to reserve a decision on whether to go for a fifth boat until later in the year. The importance of the fifth hull was in providing for an overlap which, between self-maintenance and refit periods, would ensure that two submarines were always on patrol; with only four submarines there would be periods (unless irregular patrol cycles were devised) when only one submarine might be on patrol in the best and most advantageous areas. The controlling factor was seen at this time as the life of the reactor core, which determined both the intervals between refuelling refits and the minimum refit periods, thus also constraining the patrol cycle patterns. In the first planning documents that were issued, four boats were identified as 'firm' and the fifth was 'provisional'.

It was clearly essential to begin detailed planning against the background of a general operating concept, which would establish the major areas on which attention should be concentrated; this was the function of the POLARIS Committee whose first meeting was held on 21 February 1963. It was inevitable that American ideas and experience should be taken as a model against which to set British needs: the United States Navy had been operating FBM submarines in their fleet since November 1960 with great success, and it would have been ridiculous not to use this experience and information. The general pattern of operating cycles, the provision of two crews for each boat in order to maintain a high level of operational availability, and the insistence on high maintenance standards all derived from American practice; and they pointed clearly towards the need for a well-planned operating base, with good workshop and store facilities, for missiles as well as for the rest of the weapon and ship equipments. The principal factors determining the location of this base were maximum operational utility (including access to deep water), safety and cost, and the sites considered included Devonport, Rosyth, Faslane, Loch Alsh, Invergordon and Falmouth. An additional consideration, which was only partly related to cost, was the ready availability of land, for building purposes; if land had to be bought, long delays might ensue. The question of where refits should be done also had to be considered; additional facilities would have to be provided, and although it was desirable that, to save manpower and money, these facilities should

<sup>(9)</sup> Interview.

be shared with the concurrent need to develop refit facilities for DREAD-NOUGHT and the VALIANTS, investigations would have to be made to see what had to be done to ensure that SSBN refits did not run beyond their planned time. By the middle of March it became clear that the best site, on all counts, for the operational base was Faslane, in the Gareloch, which was at that time the operational base for the Third Submarine Squadron. Rosyth was selected as the refit yard. The announcement of the decision was delayed until arrangements could be agreed with Metal Industries Limited for the loss of use of their part of the Faslane jetty in their ship-breaking business, but by the end of April, consultations could begin with the local authorities, the Scottish Special Housing Association, and the other interested parties about what the new base would mean to the area. It was the first new naval base in the United Kingdom since Rosyth was developed in 1909, and the first base calling for any major planning effort since the decision to create the Naval Base at Singapore in 1919.

It was also decided, in the same timescale, to build a training establishment, to prepare officers and men for service in the SSBNs and specifically to train both operators and some maintainers on the system hardware. The instructors for this school, and the crews of the first two submarines, would have to go to the United States for their training if they were to be ready in time, but thereafter there would be a steady requirement for training new entrants to the programme and refresher training for existing crews.

The choice of building yards presented some difficulty. Vickers Shipbuilding at Barrow was clearly identified as one that must be included; the yard had, up till that time, a monopoly of all nuclear submarine work as well as a virtual monopoly of conventional submarine work since 1950. The firm was already familiar with some of the main difficulties that were likely to be experienced in reaching improved standards of quality and cleanliness, and between them the firm and the Government had already spent £1½m. in improving the capital facilities of the yard. Vickers also had an almost unique attribute among shipbuilding firms, in a large and well-manned drawing-office. Effectively therefore the firm was obviously the first choice – indeed the only choice – for a "lead yard". In the present context, to be the lead yard would call for a good deal of effort over and beyond building a "first of class" vessel: it would extend to providing guidance drawings and construction and fitting schedules to other yards to supplement those provided by the Admiralty, the bulk ordering of ship-fitted parts, spares and minor equipments (which BUSHIPS and EB said amounted to 30,000 items for each vessel), and training and indoctrination in the required standards of welding, safety, cleanliness and quality control.

It was at least possible to envisage Vickers building all the new submarines, but it was highly unlikely that the expansion of facilities and the labour force that would be necessary to complete four or five vessels to a constricted time schedule could be justified from any longer term viewpoint: even the most optimistic Admiralty plans only envisaged a hunter-

killer being laid down every nine months, and that would not justify a three or four stream construction plan beyond POLARIS. It was therefore decided that Vickers should be invited to build two of the four submarines in the initial programme, and to act as the lead yard. The Controller of the Navy met the firm's representatives to discuss the proposition on 4 February, and a formal letter of intent was sent on 18 February. The question then was to find another shipyard. Two had relatively recent experience in building conventional submarines: Cammell Laird, Birkenhead and Scotts at Greenock. The Royal Dockyard at Devonport was also considered. Cammell Laird was the second largest ship-building firm in the country, but Scotts was relatively small, and it was likely that they would have to link forces with other builders in the area.<sup>(10)</sup> Representatives from Cammells and Scotts visited Barrow on 19 March to be briefed on the general requirements of nuclear submarine building, and after further discussions with the Admiralty, both firms were formally invited to tender for contracts for two SSBNs on 25 March. It was clear that at this stage none of the main contracts could be based on agreed or fixed prices, but it was proposed that for the second yard, as well as for Vickers, prices should be agreed as work progressed; the firms were to conform to specified reporting and progress requirements and were asked to state their expectations on two issues in particular: the fixed fee they expected as profit (in relation to an estimated construction cost), and the amount of capital they were prepared to invest, as part of the cost of the capital facilities that would be required to meet the contract requirements. The Admiralty would provide some equipment and was prepared to assist with a capital grant.

After examination of the tenders, Cammell Laird were chosen and a letter of intent went to the firm on 7 May 1963, for two SSBNs. Vickers had by then already additionally been given the charge to establish adequate formal arrangements with the Electric Boat Company to obtain the information about ship-fitted parts which neither SP nor BUSHIPS could provide.

Information from the Americans became increasingly important: general briefings, about principles, were still useful and indeed necessary for the people who were beginning to join CPE's organisation in sizeable numbers, but the ship designers, the weapons engineers, and the financiers now needed hard facts and details. It was all very well to set a general aim of getting the first boat on patrol in five and a half years, with the others following at six monthly intervals thereafter, but this would only be possible if good intentions could be turned into action: if planning, ordering and control mechanisms were set up urgently to create and maintain an impetus towards success. Organisationally, the existence of the DREADNOUGHT Project Team meant that at least on the submarine side, a design team (eventually 80 strong) was in being, tight-

(10) Cammell Laird's total work-force at the time was just under 2,500, and Scotts about 800.

ly organised and able to get under way very quickly. The outline design of the SSBN, based upon the VALIANT design, was available for approval by the Board in June 1963; but a lot of detailed work remained to be done (for example in redesigning the main valves in the light of information obtained from the USN after the accident to the U.S.S. THRESHER). A good deal of this detail was not handily available: separate contracts for information, and for the identification and procurement of equipment had to be arranged with the Electric Boat Company, in parallel to the links being established between EB and Vickers.

Even in areas specifically covered by the Sales Agreement it became clear that information was not immediately available. A realisation of what the Joint Programme would mean for SP took some time to work out; the goodwill and the obligation existed, but the documents, at any rate in adequate quantities, did not: and even had they done, SP was responsible for ensuring that they were 'sanitized', to omit details, relating to the ship-propulsion interface and the missile-reentry system interface, for which no provision had been made in the Sales Agreement. Packs of documents and books did not begin to be dispatched until some time after the Sales Agreement had been signed, and the delays led to some frustration and impatience. One of the difficulties was to be sure to extract the most important and necessary information first, and the willingness of SP staff to co-operate helped to mitigate tension and to establish good working relationships. Special Projects management staff had been so preoccupied with their own national programme and with completing the Sales Agreement negotiations that they had not given very much attention to the administrative problems that were likely to arise in passing on large quantities of documents and other information, and a number of specific difficulties arose which were resolved only by individual and sometimes unsystematic initiatives. It was not until September or October that a general set of procedures had been established, and a steady flow of material properly organised.<sup>(11)</sup>

The first hurdle to clear was to specify to the United States Government what the initial programme was to be based upon;<sup>(12)</sup> and by the middle of March the only remaining major item to be settled was the choice of missile. A preliminary operational concept was prepared by the Naval Staff at the end of January; by the end of February the POLARIS Committee had determined that the submarines would require an operational base, rather than a depot ship, and that specific provision would be needed for refit facilities; that the submarines should be built so as to give them an inherent capability to operate East of Suez if that should subsequently prove to be desirable, and that, so far as the Admiralty was concerned, the missile system to be procured should be the A3. This proved to be a major and contentious issue between the Admiralty and the Ministry of Aviation. At the time of the original SKYBOLT agree-

(11) Interview.

(12) See Appendix I [Article III (I) of the Sales Agreement].

ment in 1960, the earliest mark of the POLARIS family of missiles, the A1, was undergoing final proving trials, and the A2 was beginning flight trials;(13) by the time of Nassau, A2 had been in service as a proved system for over a year. Firing trials of the bigger and more advanced A3 were under way, and the submarines to carry the system were under construction. There was no doubt at all about the soundness or operational validity of A2; and there were British warhead designs already in being which could be adapted to fit.

The safest posture for the United Kingdom government was to delay a choice, to wait until the operational characteristics and reliability of the A3 system were proved one way or the other.(14) But this was the one option they could not choose; if the British submarines were to be built in the shortest possible timespan, the orders for equipment must be placed soon – and if the choice was to be A2, the orders for the fire-control, launcher and navigation subsystems must be placed almost at once, before United States contractors passed on irrevocably to the A3 equipment. In any event the United States authorities were pressing, in the Sales Agreement negotiations, for an early identification of United Kingdom choices so that they could themselves make plans to provide the assistance which was their obligation. In the Ministry of Aviation the engineers and scientists, consulting Sir Solly Zuckerman's staff, grappled with calculations of risk which were all too familiar to them as R and D problems: were the difficulties with A3 transitory or were they fundamental? Ought the government to be advised to be satisfied with a solution of *adequacy*, accepting A2 as good enough for their purposes, and not run the risks which still seemed real enough not only to threaten this third attempt to maintain the nuclear deterrent, but once again to put us upon the rack of dependence on American assertions and an engineering effort in which we had no effective part to play?

The Admiralty was in no doubt what it wanted. Even before a joint Navy-M OA exploratory mission went to Washington in early March to try and establish what the precise position was, it pointed out the undoubted advantages of the A3. The great increase in range was an enormous benefit and increased operational flexibility several times over and the system was designed to give much greater accuracy, at all ranges, and some opportunity for further development. Finally, A2 was to go out of production not later than 1965 – long before the British submarines could be operational: it would then be an obsolescent system, and the British and American main deployments would not be compatible. The general thrust of the argument centred on two points.

(13) A1 1250 nautical miles, A2 1500 nautical miles range: A2 had originally been intended to be the standard equipment but A1 had been adopted, as a technically less demanding concept, in order to meet the accelerated deployment plan ordered in 1958.

(14) The A3 test programme began on 7 August 1962, and 34 test launches were undertaken. The eventual score was: – *Land pad launches*; 23:9 “only partial” successes, 14 successful *Launches from U.S.S. OBSERVATION ISLAND*; 9:4 “partial”, 5 successful *Launches from SSBNs*; 2: both successful. See *Aviation Week and Space Technology*, 4 May 1964.

The Admiralty was concerned with the advantages of the A3 system as a whole, while the Ministry of Aviation was preoccupied with the missile; and the Admiralty believed that the commitment of the US Navy, and Special Projects in particular, to make the A3 system work satisfactorily was so great that, in effect, no real risk to the United Kingdom programme would be incurred. The Minister of Aviation still exhibited doubts, and pointed out that a re-entry system design to fit the A3 missile would create many problems. Even after the mission returned towards the end of March, the issue dragged on, and a final confirmatory decision, to go for A3, was not taken until 10 June, and then only after a good deal of pressure from CPE, whose need for detailed information was becoming more and more acute, and whose organisation to process and handle it was now nearly complete.

Provision was made in the Sales Agreement for an exchange of liaison offices in London and Washington, and the head of the British liaison team (SPRN) arrived in Washington on the day the Agreement was signed. Captain P. G. La Niece had, as an Assistant Director in the Weapons Department, been concerned with nuclear safety and had been a member of the Admiralty/Aviation joint mission in March. From this and from his earlier experiences as a staff officer in Washington he already knew a good range of SP personalities, and was generally familiar with the requirements he must fulfil. In general his task was more positive and extensive than that likely to fall to the American liaison team in the United Kingdom (SPUK); SP was the hub of activity, and while SPUK could, and did, perform excellent service in providing information and advice to CPE,(15) SPRN's function was to get to know as quickly as possible how the SP system of management worked, and to use this knowledge to best advantage for the United Kingdom programme: in facilitating the flow of information, in advising on how best to fulfil needs and requirements, and in interpreting British needs to the Americans. The general idea in planning the SPRN team was to have a staff officer, either full time or part time, covering the major areas of the SP organisation. This was particularly necessary in SP's Technical Division, but it was unlikely that enough officers could be made available to provide for this cover on a head-to-function basis, and some other needs were equally important to cover. So, a Constructor was appointed to SPRN's staff but was based at the EB shipyard at Groton, and the Staff Constructor appointed for duty with CBNS doubled up for SPRN's interests in the relevant technical division at the Washington headquarters (SP 26). Other BNS staff, for example in radio and navigational aids matters, also provided assistance. The staff was a mixed naval and civilian office, and a joint Admiralty/Ministry of Aviation organisation, but it was several months before a full complement was finally appointed, and several

(15) The United States liaison team eventually consisted of offices in London and Bath, and specialist advisers in Barrow, Birkenhead and Faslane. Because of the illness of the first senior officer appointed to the London office of CPE, and the difficulty of finding a replacement, the appointment of SPUK was not filled on a normal basis until January 1964.



weeks before the nucleus of the staff had adequate accommodation. In early April, SP had still not really sized up what their new international task was to be: office space was not ready, and the branches, in both the Technical and the Financial Divisions, were not yet fully briefed. Captain La Niece found an early example of this in setting up the Trust Fund. The Sales Agreement made provision for payments in respect of goods and services to be made through a Trust Fund, which acted as a form of contingency account. An initial payment was to be made on the entry into force of the Agreement. Two days after his arrival, La Niece was asked to hold a press briefing and found himself having to deal with questions of detail including enquiries about the Trust Fund payment. What he could not say was that both the British and American staffs had no idea how to handle the payment; Treasury authority to deposit a million dollars had been given, but the Treasury and Supply Delegation in the British Embassy had no machinery for paying in sums of such size in the ordinary way, so they had to draw a cheque on the United Kingdom government account. And the United States government had to discover who might be authorised to receive it! The Finance Section in Special Projects (SP 13) had no authority at that time either to receive monies from foreign governments, or to hold a Trust Fund account that was separate from their own budget; but eventually an office in the Pentagon was discovered that did have an appropriate legal remit and the money was paid over.

Nevertheless SP liaison was very willing and open and, once the Sales Agreement had been concluded, great efforts were made to meet the demands of the Joint Programme.

Unreadiness was also apparent in Whitehall. The difficulties in relation to the Ministry of Aviation have already been mentioned, but there were intrinsic reasons why matters relating to nuclear weapons should be sensitive and difficult to organise. The Treasury too had difficulties; the shift from SKYBOLT to POLARIS, from RAF to Royal Navy, was difficult to evaluate, and the consequences for the rest of the defence programme pointed clearly only to one conclusion: that this new arrangement would produce a bulge in expenditure in the late 1960s. How big it was actually going to be, and how it might be contained preoccupied discussions with the Treasury through the change of government in 1964 until the winter of 1965–66 when the more general questions arising from the Labour Government's first Defence Review shifted the focus and emphasis; the Admiralty held to the view that a notionally separate "POLARIS budget" should be adopted, to identify the costs of the new programme, and to minimize, if not eradicate, the effects upon the rest of the Navy. Insofar as this fitted in with the concept of functional costings, designed to identify and to provide a basis for the better control of particular activities, there was little argument: but the Navy's claim for sanctuary was never conceded in principle. In practice, however, in the early years of the programme, it was not seriously contested, because POLARIS fed on monies that had originally been foreseen for SKYBOLT, and, to a less extent, upon notional savings that arose from the delay of the SSN construction programme. In matters of detail connected with

the programme, the Treasury generally co-operated well, although they were prone to delay in issues concerning personnel.(16)

The same was true of the Admiralty itself. The onset of the POLARIS programme was, within the Navy, a controversial matter, centring around the fear that the new responsibility would deleteriously affect the rest of the Navy, the 'proper' Navy. To the extent that this fear could be substantiated, the concern that the Navy would not be given the extra money to provide for the new commitment was based partly upon an awareness of the general pressure under which the defence budget as a whole was placed, and partly from an observation that the V-bomber force had been so well provided for by the RAF that it constituted an *elite* force perhaps even to the extent that other functions and purposes may have suffered. Whether the Navy could now stake a claim for better treatment had yet to be established: but quite early on, the financial specialists in the Admiralty secretariat foresaw that the real difficulties would be likely to arise after the initial building period had been completed and when the question of 'extra' money had to be related to the maintenance, or replenishment, of an existing capability and, of course, when the 'novelty' of POLARIS had worn off. The other and more immediate area for concern was manpower; the manpower bill for POLARIS would be much less than for the V-bombers, but it had to be found from a Navy in which recruiting was already a matter for concern, and where even a relatively generous increase in the allowable numbers in Vote A because of the extra commitment would do nothing at all, either to produce the extra bodies from the free labour market which recruiting had recently become, or to plug the gaps which the diversion of specialist and highly trained officers and ratings to the POLARIS function would, at least in the short term, create. Similar, though less crucial, considerations applied in the civilian field, where shortages, particularly of engineering, technical and drawing office staff, persisted. The initial build-up of CPE's staff illustrated the 'concertina' effect: Admiral Mackenzie himself was relieved at Fort Blockhouse, *pro tem*, by his Chief of Staff, acting as a Commodore and a new Flag Officer was not appointed until seven months later; his Naval Assistant in CPE, and no fewer than three of the initial appointments to Bath and Washington, were hoicked off ships at very short notice. More were to follow, and a number of naval, and civil, appointments elsewhere in the Admiralty had to be left unfilled, some of them for months, while CPE was staffed up. This had to be accepted; but it was not accepted everywhere with the same willingness. It is difficult to generalise accurately, but it is possible to identify a strong current of feeling, particularly among senior officers but by no means limited to the Flag List, that POLARIS was "a frightful chore". Not only was the maintenance of the deterrent a function removed from the traditional range of naval responsibilities, but its inclusion in a submarine force was less than fully welcome. Some submariners at any rate felt that

(16) One such example was the delay incurred in settling upon rates of local allowances for ratings under training at the FBM Training Facility, Dam Neck, Virginia.

the Royal Navy was, emotionally, anti-submarine rather than pro-submarine. It was certainly true that in an earlier period, between the wars, the Submarine Service had been at the bottom of the list of priorities for new construction. Submarines and submariners constituted a private navy, separate, secretive and, if the truth be told, rather furtive; it was not very often that they came into regular contact with the rest of the Fleet and even when they did it was to epitomize a threat that a very high proportion of senior officers had spent their careers combatting. It was said that not many submariners reached flag rank, even proportionately to their numbers in the officer corps; and not one, at that time, had ever become First Sea Lord.<sup>(17)</sup> It was of course true that the submarine service was not the only "private navy"; the Fleet Air Arm had much the same aura, and was much more expensive. But there were structural differences between the two groups which had an important effect. The Fleet Air Arm was much better organised to influence the development of naval policy, even apart from any difference which may have existed because of the great importance of maritime air power in and since the Second World War. FOSM was an operational sub-command, but FO Air (Home) was a major area command, with resources in staff, and support in the Naval Air Divisions of the Naval Staff that the submariners could not, or at any rate did not, match. There was no reserved spokesman for them on the Board, as the Fifth Sea Lord had been for the aviators. FOSM remained the Board's principal adviser on submarine matters, but he was physically removed from day-to-day contact with the rest of the Naval Staff and had little effect upon the day-to-day interplay of affairs. To the extent that there was any substance to these feelings, on the one hand of distinctiveness and on the other of deprivation, then part of the fault lay with the submarine service, and especially with successive FOSM, who did very little to change their position in the system of organisation, and consistently resisted any opportunity to remit any part of their responsibilities to a naval staff division at headquarters.

### Methods and management

The lack of knowledge about what the POLARIS programme entailed could not be allowed to persist; it was not only inimical to the position of CPE within the Admiralty, and might give rise to all sorts of misunderstanding and misrepresentation, but might also positively react so as to impede the achievement of the programme's aims, if positive cooperation was withheld. So from every point of view it was in CPE's interest to explain what the programme was and what its effects would – and would

(17) The concept of what a "fair share" of promotions would be is virtually impossible to establish, insofar as only a small number of specialist Captains' appointments were available in the submarine world. Successful submariners, like Admiral Mackenzie himself and Admiral Sir David Luce, who became First Sea Lord, made their careers, and their reputations as senior officers, in other parts of the naval service.

not – be to the rest of the Admiralty and the other Government departments associated in the endeavour. In the early stages, it was difficult to do this except in very general terms, explaining the remit given to the Executive and the authority given to Admiral Mackenzie as the national Project Officer. It became easier from the summer of 1963 onwards, when a series of major decisions had given a finite shape to the programme, when contracts had been initiated and physical signs of progress began to show: and when a sufficient body of United States information became available so that a useful level of detail could be included, in the preparation of illustrated talks and lectures, for naval establishments, reserve units and invited audiences in the CPE Management Centre. Besides exegesis, CPE could practise performance, and this was done principally in two ways. The first was to perform ordinary functions smartly: to issue the minutes of meetings within 48 hours of the meeting taking place, to answer letters promptly, to follow up action efficiently. To be seen to be practising urgency was a virtue in itself: to be known to be the first Admiralty division to procure a Thermofax photocopier, to have authority to make trans-Atlantic telephone calls without question, and delegated authority to approve air passages, all helped in a minor way to establish a reputation for accomplishment – *in posse*, if by no means yet *in esse*. The second way which initially was of Admiral Mackenzie's own choosing but which fitted in very well with the subsequent choice of management techniques, was to emphasise the positive capacity of management: to offer assistance in overcoming difficulties, rather than recrimination. It required the assumption, which it was hoped would be encouraging, that the offender who was falling short of his target was in good conscience striving for the desired end, and merely needed a little help. If the offer was spurned it might be necessary to apply more pressure to ensure that objectives were clearly understood, and to give some explanation to show what the effects of not meeting them might be to the rest of the programme. But the assumption was maintained that the importance of succeeding in the POLARIS programme – for the reputation of the whole of the naval service – was unquestioned and, indeed, unquestionable. If it were not, CPE could raise the matter directly at Ministerial or Board level. But this was an ultimate power, only likely to be useful if used sparingly in ultimate courses; and both CPE and his *confreres* in other parts of the Admiralty were aware of this. But he could, and did, meet regularly with Board members, including the First Lord, and kept them informed of progress, or the lack of it, without necessarily invoking his "right of appeal".

Such practices, however useful in particular circumstances, could not be effective substitutes for a systematic concept of management, though they might help to shape a distinctive style. The organisation of CPE – deriving from the "Le Fanu blueprint" – was a pragmatic, and rather modified, type of project organisation in which a particular set of responsibilities was laid upon an identifiable group. In fact, this was by no means the classical pattern of project organisation; the mixture of responsibilities and resources, and the utilisation of "allocated" and "desig-

nated" staff to supplement the core of the project team made it very much an *ad hoc* grouping. In truth it derived from two origins: the defined need to push a special programme through against constraints expressed initially in terms of time-goals, and the perceived desirability of emulating the successful paradigm with which the British programme was to be associated and against which its achievements would stand to be compared: the Special Projects Office. The POLARIS Sales Agreement, with its emphasis upon the connexion between the two national programmes, and the parallel identification of the two national project teams, emphasised the relationship.

A major problem area therefore became the extent to which CPE should adopt – or adapt – SP's management practices; and of course there were obvious and early difficulties. It simply was not possible to conform *in toto*: the legislative and administrative environments were quite distinctively different. The political environments too were quite different, both in terms of overt and general support for the programme and because CPE could never hope to capitalize directly upon SP's proven record of successful innovation. The problems of building a partnership with industry were of a totally different order, as well; and the receptivity of both government bodies and contractors to the requirement to change some of their practices and improve some of their standards had still to be tested. So CPE had to evaluate what SP did – and to establish whether the substance differed from the myth – and then to judge what could be successfully transplanted, bearing in mind that any innovation would have to be of direct utility, and thence of direct appeal. Imitation only for the sake of imitation would cut very little ice, inside or outside the project.

Yet clearly there had to be a measure of compatibility: progress reports, statements of requirements and so on, would need to be in a form that did not complicate SP's own business of getting on with the United States national programme more than was absolutely essential, and would facilitate their understanding of British needs. The British would need to learn how to work the SP system for their own purposes, as well as to use its best features for their own needs; and in order to speed this process, the Admiralty's Organisation and Methods division were asked to make specialist advice available to CPE on a full-time basis, in January 1963.

By this time SP's battery of management techniques had developed very considerably beyond the innovations associated with the early days of the FBM programme, which had become quite well known and widely reported.<sup>(18)</sup> Several of the most crucial, for example the authority to present and manage a consolidated budget through the Navy Management Fund,<sup>(19)</sup> had received less public attention than the reporting, estimating and control techniques, like the Programme Evaluation and

(18) See, for example, Sapolsky, *The Polaris System Development*, Chapters 2 and 4.

(19) See Sapolsky *op. cit.* pp. 184 *et seq.*

Review Technique (PERT), which had possibilities of adaptation and use outside the government service. One or two, like the system of configuration control, which sought to impose a comprehensive discipline upon engineering documentation and equipment, had received hardly any public notice at all (and consequently could not be "read up"). The general philosophy to which they all related was, in essence, relatively straightforward.

The concept of 'management by exception' provided that programme goals and schedules, drawn up by authorities responsible for their achievement after discussion with SP management, should be coordinated and transmitted by procedures commonly employed throughout the programme so that the whole fitted together; and that these responsible parties should be left to get on with their jobs, seeking assistance from the next responsible layer of management only when they needed assistance. Then, either management support or additional resources would be provided, in a way which ensured as far as possible that the main aim was still achieved. Some functions were less crucial to this main objective than others, so that slippages in time might be tolerable; others might be so essential that virtually any extra cost would be justified, so as not to prejudice the timely and successful completion of the task. To know which was which required an extensive knowledge of the interactions between the various parts of a very wide-ranging and extensive enterprise, and this called for not only special techniques but a monitoring service for senior management which both provided information and a check against overloading the reporting system with too much detail. It also provided a degree of assurance against the honesty of reports, without which the whole concept would become useless. Management by exception called for extensive delegation and trust; from a number of points of view it had been forced upon Admiral Raborn<sup>(20)</sup> in the early days of SP because he had had little opportunity of creating any highly centralized system of control: the necessary range of resources was not available within the United States government service and the physical spread of the programme throughout the length and breadth of the United States made it unlikely to succeed in any event. His great contribution to the management of the FBM programme had been to turn these disabilities to positive virtues, and he had been greatly assisted by the perceived necessity of the programme in the wake of SPUTNIK, when a successful programme could become equated with a patriotic obligation. The partnership between government and industry was no empty boast. It meant however that many features of the *regime* were totally unfamiliar to the British in 1963, even to those who had some knowledge of more conventional US Navy practices. There was for example a very much greater dependence upon civilian contractors to provide information and assistance, even in matters of equipment design and financial control, than

(20) Rear Admiral "Red" Raborn was the first director of SP; he was succeeded by Rear Admiral I. J. Galantin, who in turn was succeeded by Rear Admiral Levering Smith.

Admiralty officials had ever seen: SP had relatively few resources at headquarters and, to British officials' eyes, relatively little knowledge about details.

The seconded O & M staff set up a Programme Evaluation section in CPE's London office in January 1963, and spent a settling-in period assisting the Assistant Polaris Executive develop a simple programme plan which became LONGCAST 1. It was based upon a fixed time-goal which helped to give shape to the emerging pattern of organisation; it was not yet clear what the relationships between the focal points in London, Bath and Washington would become precisely but the general division of function between London and Bath, between general policy and technical affairs, was already evident. It was already evident too that within the sections of the former DREADNOUGHT Project Team, there was already a well-staffed and experienced team used to providing progress information and reports from Vickers Shipbuilding and the DREADNOUGHT and VALIANT. Although it would be desirable for this information to be reported in a style consonant with that which might be used elsewhere in CPE's organisation, there was no good reason – except perhaps to emphasize that the group was now part of a larger whole, whose responsibilities extended beyond linkages with one set of contractors – to upend a working system.

The principal management information techniques to which CPE was attracted could be limited to three: network analysis, programme management plans and stylised management meetings.

The principles of network analysis, or critical path scheduling, had already become known and were already in use in a number of industries, including the building industry. Admiralty experience in the ship field was effectively limited to a pilot study employed during the refit of H.M.S. BULWARK in 1960–61. Initially the attempt was made to apply the technique to the whole submarine construction process with the aim of constructing a 'master network'; the theoretical aim was to create a system of control which spread downwards from the top, but it proved to be extremely difficult to execute and to be fallacious in conception. The reality for this type of technique is to evolve a method of control from the bottom up, and CPE had neither the time nor the resources to allocate to create the linkages that would be required between the relatively small scale networks that were successfully devised. The effective use of network analysis never extended beyond sub-manager level: but it proved useful there, and the effort which was made in 1963 to educate Admiralty and CPE staff in the theoretical use of the technique was eventually justified, insofar that at various levels from Controller of the Navy to main grade professional and senior executive officer, the technique was demonstrated to be useful – but no easy or universal panacea. Eight one day or half day courses were organised, at which an outside consultant demonstrated the utility of the technique; they were simple courses, with the usual risks of over-simplification, but, not least because Board members like Admiral Le Fanu took part and let it be known that their senior, as well as their middle grade, staff should attend also, they did some good

in stimulating CPE's image of urgency as well as in general education.(21)

In a similar way, CPE began to develop the use of Programme Management Plans and to embody them in progress meetings. The essential lesson to draw from SP was what management precisely used their control techniques to monitor. The head of the Programme Evaluation Section formed the view, after visiting the Special Projects Office and discussing the issues in Bath and London, with American as well as British colleagues, that there was no point in endeavouring to emulate the independent monitoring function which it was said SP 12 performed for the SP Management Team; it was doubtful from the British point of view whether this function was then sufficiently well developed to be worth emulating and it was pretty certain that CPE could never find the necessary resources for his relatively small programme. What monitoring of managers' reports was to be done would have to be done with CPE front office support, and at least the tacit acceptance of sub-system managers: what CPE could try and transfer direct from SP was the sense of confidence and style.

Programme Management Plans (PMP) are a distinctive form of bar charting, broken down into 'families' systematically from levels of general aims to discrete and particular functions. They identify the agencies who are responsible for or principally affected by *the lack of progress* towards completion: not so that they may be blamed, but in order that they can be warned ahead of time of likely difficulties and assisted in resolving them. A common format allowed standardized reporting at meetings – and discouraged 'representational' reporting. But it meant a lengthy period of initiation and practice, and met with a good deal of initial scepticism. Eventually however the general utility of having a common and relatively simple 'programme language' became accepted, and some of the most vehement early critics became disciples, using the technique in subsequent appointments elsewhere in the naval service.(22) Instructions about compiling Programme Management Plans and other standardized reports were embodied in an Organisation Manual, which was first circulated in January 1964. It also included short job-descriptions for senior and middle management staff throughout the Executive, and the definitions of responsibility *vis-à-vis* CPE and his main collaborators, like the Directors General, Ships and Weapons.

A new and stylized form of fortnightly progress meetings was begun in July 1963, when area, or 'field' managers were required to adopt a common format of report: assessing the current position within their area of responsibility, reporting objectively upon the status of their objectives, identifying forthcoming milestones of significance, and substantiating their analysis of the status if the position was unsatisfactory. It was all a

(21) This small example was quite useful in exposing senior staff to what POLARIS was about. In normal circumstances, knowledge of new techniques, like training courses, tend to be reserved for junior staff: and senior staff hold aloof, perhaps in the mistaken belief that experience is, in every case, a substitute for training.

(22) Interviews. See Appendix IV for details of a PMP 'tree'.

bit theatrical, and frankly emulative of the weekly 'Monday morning meeting' in SP; but it did help to cut across managers' instinctive dislike of owning up to failure, by making it more difficult to hide behind articulate verbiage. The public declaration of the programme's aims helped also to encourage frankness, and the presence of contractors' representatives assisted too. The theatricality, arising in part from meeting in a specially secure conference room and from making one's report from a podium, with standardized graphic aids, was novel and discouraging to the introverted: it was perhaps fortunate that there were very few such in the programme. It also smacked a little of Buchmanite 'fellowship' or the confessionals of the more restrained fundamentalist sects, but on the other hand 'open reports, openly arrived at' did tend to establish a corporate feeling within the programme. The success of such meetings depended upon strong chairmanship which maintained the impetus of the meeting and eliminated mud-slinging. Post-mortems and arguments were reserved for subsequent, private, meetings of the management team. CPE was briefed before the meeting by the Programme Evaluation Section who had the substance of the reports for the meeting at least the night before it took place.(23)

The management team formally consisted of the Chief Executive, the Technical Director, the naval deputy (not least in his capacity as the Chief Planning Officer), the Chief Administrative Officer and the Ministry of Aviation project officer; other directing staff, most notably the deputy technical director for weapons and the logistics officer, attended frequently for specific items of business. The meetings were conducted formally, but there were seldom specific papers to discuss: most of the business arose out of the progress meetings, or from major issues which had previously been discussed informally. The management team operated as a group, after an initial period of assimilation; discussion was not conducted on a 'representative' basis – the progress meetings and the wide dissemination of information which they manifested provided a relatively high level of jointly-shared knowledge which in turn tended to emphasise the corporate nature of the group's function. No member of the team regarded his professional field as immune from discussion, and when a decision was made, it was the result of a joint determination about what should be done.

The development of control and analysis techniques was clearly of considerable importance, especially in a programme in which American and British hardware and management were to be mingled, but it could not displace the need for a management philosophy, which went even closer to the heart of the problem than a general determination to meet time and cost goals. The United Kingdom programme needed to establish what in a normal programme would be called the design philosophy. One of the staff used to explain it thus: "the development of a new system is like first having and then bringing up a baby. An idea is conceived and a system is born: and before it comes into service you have to work out how

it is going to be supplied and serviced. Normally there is time to decide on the limitations and constraints which you think it will be right to impose. The POLARIS programme was like being asked to adopt a baby that already had a personality of its own, and being given a list of its likes and dislikes, and a copy of Dr. Spock: and being told to adapt the rest of the household to this lusty brat's habits while also being required to learn how to change nappies. It is not a very exact simile but it helps to explain in part why the task seemed so absorbing: and why occasionally the baby woke up during the night."

There were a number of considerations which all worked in the same direction. The experience of DPT on the DREADNOUGHT/VALIANT programmes reinforced Rowland Baker's professional instinct that the British POLARIS submarines should, to the greatest extent possible, be standard vessels built identically from a well defined design. This was necessary not only because of the need to house POLARIS weapon system equipment compatibly but because of the need to impose high safety standards and the desire to maintain close control over the shipbuilders' techniques and practices. The weapons engineers, mostly with a background in guided weapons or aerospace, needed no conversion to the ideal of tightly specified standards and procedures, effective throughout the system as a whole. But they had an additional concern, only partly related to the time constraints imposed politically upon the programme; this was to standardize upon United States designs and procedures. It was consonant with SP's advice about design-to-manufacture, and compatible with the responsibility which SP had assumed under the Sales Agreement to ensure the delivery and installation of a working system. It was also consistent with an instinct to reduce any divergences from the successful United States achievement to the absolute minimum; but, in addition, it sought to stifle the equally instinctive urge which every resourceful engineer apparently possesses, to believe that any system or equipment which he has not designed himself is capable of alterations which may be represented as improvements – given time and money. This may be identified as the "N.I.H., or not-invented-here" syndrome; and it is not necessarily xenophobic only in international terms. It sometimes manifests itself in different parts of what is ostensibly the same organisation.

The initial function of the weapon group in the Technical Directorate was therefore to consolidate their information and to test the extent to which it might be possible to enforce the barest minimum of change. At the outset, Captain Shepherd had no set ideas about the form or nature of the technical relationships between SP and CPE, other than a feeling of the need to get as much information as early as possible. He did, on the other hand, have a very firm view, based on his own experience, of the necessity to involve the ship-builders in weapon system testing and tuning, and he shared with Rowland Baker the disinclination to fiddle around with proved designs.(24) The "system concept" was not a novel

(23) Interviews.

(24) Interview.

principle in 1963, but actual experience of the practice in the Service was limited: aerospace and guided weapons were the most obvious examples, where the technical reliability of relatively small components and the need for good safety standards were of a very high priority and evident importance.

How then would the British system differ from the United States FBM package? The ship itself was the biggest area of difference, not merely in relation to the hull but also because supporting equipments like communications and sonar would be of British design and manufacture. Some of these equipments would involve research and development, and although it was in general true that the United Kingdom tended to go for simpler designs than the US, Captain Shepherd's group was very conscious of the probability that any R & D effort involved the risk of time-lag, of failure to meet the unusually specific time-goals for the deployment of the complete system. Other R & D areas which had to be faced were the re-entry system for the missile, the hovering gear for the submarines, the high quality welding that would be necessary in fabricating the submarine hulls, and a line-of-sight technique that would replace the line-of-sight function of the US Mark XI periscope.<sup>(25)</sup> This requirement was the only major consequence of the decision to omit the Mark XI periscope; the periscope had originally been incorporated in the American boats as a multiple function instrument which provided back-up assurance for other equipments in the early days of the United States programme. By 1963 this particular "belt and braces" provision had been obviated by the good performance of the fitted ship's inertial navigation system (SINS). The periscope was not integrated into the weapon system and, with the exception of the line-of-sight function, could be omitted without major effect.

In addition there were a number of areas where British experience, especially in the Royal Navy, was relatively unfamiliar with technical standards embodied in the United States FBM system. No British missile or rocket had employed large diameter solid fuel motors of the size or sophistication of those in the POLARIS missiles, and although it was not initially an area of concern, it became so in 1966-67 when problems of storage, handling and reliability checks had to be mastered. Nor was there much experience with advanced inertial guidance systems, which called for tightly controlled standards of care, and of accuracy. Finally, POLARIS involved specialized on-board and in-flight computing equipment of which the Royal Navy had no experience at all. All of these presented specific problems of familiarization and of learning to cope; problems associated with the production of the equipment were principally and primarily the care of the United States government, on whose agents the United Kingdom had to depend.

(25) Interview.

## Problem areas

Discussions with Special Projects about the implications of these areas of policy began in the summer of 1963 as more and more detail began to be added to the outline programme. They focussed on the provision in the initial SP budget for 'management services' where the finance branch (SP 13), in default of any other guidelines, provided for contractors' personnel and services on something of the scale which SP Branches used for themselves. The amount of money thus identified was greater than anyone in CPE had expected, and the British members of the Joint Programme were still sufficiently unfamiliar with SP practices that they had made the implicit assumption that many routine functions, like providing documentation and information, would have been covered by the quarterly overhead contributions. There was also some initial suspicion that United States commercial contractors were trying to enhance their necessity to the United Kingdom programme. Special Projects sent a team to London and Bath in August to explain the basis of the estimates, and of SP's use of contractors' resources, and the matter was raised at the second Joint Steering Task Group meeting in September. The misunderstandings which were revealed caused both sides to articulate their positions with some care and, as a consequence, Captain Shepherd took a group to Washington in October which discussed CPE's thoughts for the delineation of responsibilities for testing and tuning equipment with SP's technical management staff and drew up with them a draft section for the Technical Arrangements which specified these responsibilities in considerable detail. The group, supported by SP and SPRN representatives, then visited the plants of all the major weapon system contractors to explain the agreed policy, and to establish whether, from the contractors' point of view, a workable system had been devised. As a result of this exercise, it became possible within a very short time to identify who would provide what, in terms of handbooks, diagrams, test schedules, test checks, advisory personnel, training programmes, back-up services and so on and, consequently, what the costs would be, and how they would be controlled, in some detail. It proved to be a very important achievement, not only in helping to establish a high degree of confidence between the technical and financial staffs in SP and CPE, but also in establishing a model procedure for dealing with other areas of concern.

One such area was the training school: the Royal Naval Polaris School (RNPS), which was to be built alongside the operating base at Faslane. The original conception for this part of the programme was a fairly generalised requirement for a training facility where initial and refresher training on POLARIS weapon system equipment could be given to submarine crews and some workshop staff. It was accepted that the training of the crews for the first two boats at least, and of the School's instructional staff, would need to be done in the United States, and arrangements were made accordingly; but it was desirable that the School should be set up as soon as possible, and it became increasingly clear that the building of the School offered an opportunity to have a "dry run" in setting an

installed weapon system to work. The equipment in the School either replicated or simulated much of the submarine-borne system, except that only one missile tube was incorporated; the functions of the other fifteen were simulated. The United States Navy had two training facilities: one, at Dam Neck, near Norfolk, Virginia, had been in operation for some years and the other, at Pearl Harbour, was under construction in 1963. They were by no means identical in layout and they both had a bias towards maintenance training. This feature made it difficult to use either as a simple model for the RNPS which was primarily aimed at operator training and the difficulty was compounded in two important ways. There was a very sharp difference of view within CPE about how much like a complete ship-type installation the RNPS should be. Captain Shepherd's group became more and more concerned that it should be as close to a ship system as possible, and should, specifically, include Test Instrumentation equipment which would allow the sub-systems to be installed and set to work in virtually the same way as in the submarines. It was a logical extension of this view that Vickers should be made responsible for the installation, testing and tuning. The idea fitted in well enough with the concept that the RNPS should be concerned primarily with operational training, and it had the utility that if the RNPS were built in this way it could later be used as a test-bed, to prove out modifications to components or alterations suggested by Special Projects and even perhaps to test out UK-unique modifications and fire-control computer tapes. The great disadvantage was, however, that this conception would call for a redesign effort which would substantially diminish the chances of being able to use either the Dam Neck or Pearl Harbour layout and installation drawings and diagrams. CPE's London staff and SPRN were chary of allowing this to happen. In the first place it looked as if the Royal Navy might be choosing to perform an important POLARIS function quite differently from the US Navy; from the point of view both of the philosophy of cooperation and of the pressure of time, this might be disfunctional. Secondly, it was by no means clear if the fortuitous advantages about a 'first of class' practice installation would be worth the risk; if the RNPS were for any reason delayed, there would be insufficient time to treat the installation as a 'dry run'. Finally, CPE would be introducing changes and unique requirements into a part of the programme where, it was already clear, SP organisation was unusually complicated from the British point of view: the FBM training facilities were supervised by a subsection of the Plans and Programs Division, and the Technical Division had only a limited degree of knowledge and control in this area. (It also became apparent later that CPE's organisation had to be altered so as to provide specially for an RNPS 'sub-project' group.)

Eventually the CPE Management Team supported Captain Shepherd's proposals, but with some reluctance in the face of the expected difficulties; a specific Technical Arrangement section to cover the work relating to the RNPS was agreed with SP and the personnel in each organisation were supplemented specifically to deal with the separate areas of responsibility. Even so the preparation of documentation, espe-

cially for the simulator equipment, was continually a problem area in 1964-5, and it was not until the School building at Faslane was nearly complete, and the weapon system equipment began to be installed in late 1965, that CPE could be sure either that the School would complete on time - the first discrete element in the programme to be commissioned - or that the benefits of the 'dry run' would be able to be applied to the testing and tuning of RESOLUTION and the succeeding boats.

The last great tussle over the definition of the initial programme in 1963-4 related to the choice of the Ships Inertial Navigation System (SINS) equipment for the submarines. In the early days of the United States programme it had been the practice in some parts of the overall weapon system to develop manufacturing capability in two or more contractors' plants. But as the system developed from A1 to A2 to A3, and as the principles of configuration control became more widely applied, the practice lapsed until, in late 1963, the navigation sub-system was the only major area in which there was still, effectively, a choice between suppliers: Sperry and Autonetics. Initially too the sub-system had included three SINS equipments, but in 1963 the US Navy was sufficiently assured of the improved reliability of the equipment to reduce the provision to two SINS in each submarine, and this was a practice which CPE eventually decided to follow. Special Projects had also, in effect, decided to concentrate upon the Autonetics model for its later submarines, although notionally Sperry was still an acceptable alternative supplier.

In the United Kingdom the use of inertial navigation techniques was still in an early stage. The Admiralty Compass Observatory (ACO) at Slough was the R & D establishment responsible for the development of a suitable sub-system for use in the hunterkiller submarines, beginning with DREADNOUGHT. It had evolved a design which intrinsically depended upon a SINS produced by Sperry (UK) that was very similar to the Sperry (US) product. There was, therefore, a case to follow this avenue of development, which would have the advantage of standardizing the navigation equipment in all British nuclear submarines, of whatever type. Against that could be set the disadvantages that the British and American POLARIS boats of otherwise similar configurations would be different, and that the British configuration would be - so CPE felt, - less advanced. Certainly it would be necessary to buy additional SINS and to set up an Ashore Navigation Centre at Slough as a test-bed on which to build up British experience and knowledge. The directing staff at ACO were very keen that this should be done, and they secured the support of the Director General, Weapons and, initially, of the Controller as well.

It was not until CPE had had time to consider what the penalties might be of diverging from the SP configuration that opinion hardened against the Sperry-ACO solution. The initial costs would not be so vastly different, but the design differences, and the difficulties of ensuring compatibility during service, seemed to be of more importance than the Director General, Weapons would allow. Perhaps of most immediate importance was the undesirability of allowing the effective control of an integral part of the weapon system to pass out of the control of the CPE -